THE

POPULAR SCIENCE MONTHLY.

JANUARY, 1893.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVIII.—FROM MAGIC TO CHEMISTRY AND PHYSICS.

By ANDREW DICKSON WHITE, LL.D., L.H.D.,
EX-PRESIDENT OF CORNELL UNIVERSITY.

PART II.

WE have seen thus far, first, how such men as Eusebius, Lactantius, and their compeers, discouraged scientific investigation as futile; next, how such men as Albert the Great, St. Thomas Aquinas, and the multitude who followed them, turned the main current of mediæval thought from science to theology; and, finally, how such Church authorities as Popes John XXII and Innocent VIII, and the heads of the great religious orders, endeavored to crush what was left of scientific research as dangerous.

Yet, injurious as all this was to the evolution of science, there was developed something far more destructive; and this was the influence of mystic theology, penetrating, permeating, sterilizing nearly every branch of science for hundreds of years. Among the forms taken by this development in the earlier middle ages we find a mixture of physical science with a pseudo-science obtained from texts of Scripture. In compounding this mixture, Jews and Christians vied with each other. In this process the sacred books were used as a fetich; every word, every letter, being considered to have a divine and hidden meaning. By combining various scriptural letters in various abstruse ways, new words of prodigious significance in magic were obtained, and among them the great word embracing the seventy-two mystical names of God—the mighty word "*Schemhamphoras.*" Why should men seek knowledge by

observation and experiment in the book of Nature, when the book of Revelation opened such treasures to the ingenious believer?

So, too, we have ancient mystical theories of number which the theological spirit had made Christian, usurping an enormous place in mediæval science. The sacred power of the number three was seen in the Trinity; in the three main divisions of the universe—the empyrean, the heavens, and the earth; in the three angelic hierarchies; in the three choirs of seraphim, cherubim, and thrones; in the three of dominions, virtues, and powers; in the three of principalities, archangels, and angels; in the three orders in the Church—bishops, priests, and deacons; in the three classes—the baptized, the communicants, and the monks; in the three degrees of attainment—light, purity, and knowledge; in the three theological virtues—faith, hope, and charity—and in much else. All this was brought into a theologico-scientific relation, then and afterward, with the three dimensions of space; with the three divisions of time—past, present, and future; with the three realms of the visible world—sky, earth, and sea; with the three constituents of man—body, soul, and spirit; with the threefold enemies of man—the flesh, the world, and the devil; with the three kingdoms in Nature—mineral, vegetable, and animal; with "the three colors"—red, yellow, and blue; with "the three eyes of the honey-bee"—and with a multitude of other analogues equally precious. The sacred power of the number seven was seen in the seven golden candlesticks and the seven churches in the Apocalypse; in the seven cardinal virtues and the seven deadly sins; in the seven liberal arts and the seven devilish arts, and, above all, in the seven sacraments. And as this proved in astrology that there could be only seven planets, so it proved in alchemy that there must be exactly seven metals in the *electrum magicum*. The twelve apostles were connected with the twelve signs in the zodiac, and with much in physical science. The seventy-two disciples, the seventy-two interpreters of the Old Testament, the seventy-two mystical names of God, were connected with the supposed fact in anatomy that there were seventy-two joints in the human frame.

Then, too, there were revived such theologic and metaphysical substitutes for scientific thought as the declaration that the perfect line is a circle, and hence that the planets must move in absolute circles—a statement which led astronomy astray even when the great truths of the Copernican theory were well in sight; also, the declaration that Nature abhors a vacuum, a statement which led physics astray until Torricelli made his experiments.

In chemistry we have the same theologic tendency to magic, and as a result a muddle of science and theology, which from one point of view seems blasphemous, and from another idiotic, but

which none the less sterilized the field of physical investigation for ages. That debased Platonism which had been such an important factor in the evolution of Christian theology from the earliest days of the Church continued its work. As everything in inorganic Nature was supposed to have spiritual significance, the doctrines of the Trinity and Incarnation were turned into an argument in behalf of the philosopher's stone: arguments for the scheme of redemption and for transubstantiation suggested others of similar construction to prove the transmutation of metals; the doctrine of the resurrection of the human body was by similar mystic jugglery connected with the processes of distillation and sublimation. Even after the middle ages were past strong men seem unable to break away from such reasoning as this;—among them such leaders as Basil Valentine in the fifteenth century, Agricola in the sixteenth, and Van Helmont in the seventeenth.

The greatest theologians aided in developing the fetichism in which much of this pseudo-science was grounded. One question largely discussed was, whether at the redemption it was necessary for God to take the human form. Thomas Aquinas answered that it was necessary, but William Occam and Duns Scotus answered that it was not; that God might have taken the form of a stone, or of a log, or of a beast. The possibilities opened to wild substitutes for science by this sort of reasoning were infinite. Men have often wondered how it was that the Arabians accomplished so much in scientific discovery as compared with Christian investigators: the reason is not far to seek; the Arabians were comparatively free from these mystic allurements, these theologic modes of thought which in Christian Europe flickered in the air on all sides, luring men into paths which led no-whither.

Strong investigators like Arnold de Villanova, Raimond Lully, Basil Valentine, Paracelsus, and their compeers, were thus drawn far out of the only paths which led to fruitful truths. In a work generally ascribed to Arnold of Villanova, the student is told that in mixing his chemicals he must repeat the psalm *Exsurge Domine*, and that on certain chemical vessels must be placed the last words of Jesus on the cross. Vincent de Beauvais insists that as the Bible declares that Noah, when five hundred years old, had children born to him, he must have possessed alchemical means of preserving life; and much later Dickinson insists that the patriarchs generally must have owed their long lives to such means. It was loudly declared that the reality of the philosopher's stone was proved by the words of St. John in the Revelation, "To the victor I will give a white stone." The reasonableness of seeking to develop gold out of the baser metals was for many generations based upon the doctrine of the resurrection of the physical body, which, though explicitly denied by St. Paul,

had become a part of the creed of the Church. Martin Luther was especially drawn to believe in the alchemistic doctrine of transmutation by this analogy. The Bible was everywhere used, both among Protestants and Catholics, in support of these mystic adulterations of science, and one writer, as late as 1751, based his alchemistic arguments on more than a hundred passages of Scripture. As an example of this sort of reasoning, we have a proof that the elect will preserve the philosopher's stone until the last judgment, drawn from a passage in St. Paul's Epistle to the Corinthians, "This treasure have we in earthen vessels."

The greatest thinkers devoted themselves to adding new ingredients to this strange mixture of scientific and theologic thought; the Catholic philosophy of Thomas Aquinas, the Protestant mysticism of Jacob Boehme, and the alchemistic reveries of Basil Valentine were all cast into this seething mass.

And when alchemy in its old form had been discredited, we find scriptural arguments no less perverse and even comical used on the other side. As an example of this, just before the great discoveries by Stahl, we find the valuable scientific efforts of Becher opposed with the following syllogism: "King Solomon, according to the Scriptures, possessed the united wisdom of heaven and earth; but King Solomon knew nothing about alchemy (or chemistry in the form which then existed), and sent his vessels to Ophir to seek gold, and levied taxes upon his subjects; *ergo* alchemy (or chemistry) has no reality or truth." And we find that Becher is absolutely turned away from his labors, and obliged to devote himself to proving that Solomon used more money than he possibly could have obtained from Ophir or his subjects, and therefore that he must have possessed a knowledge of chemical methods and the philosopher's stone as the result of them.*

* For an extract from Agrippa's Occulta Philosophia giving examples of the way in which mystical names were obtained from the Bible, see Rydberg, Magic of the Middle Ages, pp. 143 *et seq.* For the germs of many mystic beliefs regarding number and the like, which were incorporated into mediæval theology, see Zeller, Plato and the Older Academy, English translation pp. 254 and 572, and elsewhere. As to the connection of spiritual things with inorganic Nature in relation to chemistry, see Eicken, p. 634. On the injury to science wrought by Platonism acting through mediæval theology, see Hoefer, Histoire de la Chimie, vol. i, p. 90. As to the influence of mysticism upon strong men in science, see Hoefer; also Kopp, Geschichte der Alchemie, vol. i, p. 211. For a very curious Catholic treatise on sacred numbers, see the Abbé Auber, Symbolisme Religieux, Paris, 1870; and for an equally important Protestant work, see Samuell, Seven the Sacred Number, London, 1887. It is interesting to note that the latter writer, having been forced to give up the seven planets, consoles himself with the statement that "The earth is the seventh planet, counting from Neptune and calling the asteroids one" (see p. 426). For the *electrum magicum*, the seven metals composing it, and its wonderful qualities, see extracts from Paracelsus's writings in Hartman's Life of Paracelsus, London, 1887, pp. 169 *et seq.* For Basil Valentine's view, see Hoefer, vol. i. pp. 453–465; Schmieder, Geschichte der Alchemie, pp. 197–209; Allgemeine deutsche Biographie, article Basilius. For the discussions referred to on

Of the general reasoning enforced by theology regarding physical science, every age has shown examples; yet out of them all I will select but two, and I present these because they show how this mixture of theological with scientific ideas took hold upon the strongest supporters of better reasoning even after the power of mediæval theology seemed broken.

The first of these examples is Melanchthon. He was the scholar of the Reformation, and justly won the title "Preceptor of Germany"; his mind was singularly open, his sympathies broad, and his freedom from bigotry drew down upon him that wrath of Protestant heresy-hunters which embittered the last years of his life and tortured him upon his death-bed. During his career at the University of Wittenberg he gave a course of lectures on physics. In this he dwells upon scriptural texts as affording scientific proofs, accepts the interference of the devil in physical phenomena as in other directions, and applies the mediæval theological method throughout his whole work.*

Yet far more remarkable was the example, a century later, of the man who more than any other led the modern world out of the path opened by Aquinas, and into that which Roger Bacon had sought to open and which has led modern thought to its greatest conquests. Strange as it may at first seem, Francis Bacon, whose keenness of sight revealed the delusions of the old path and the promises of the new, and whose boldness did so much to turn the world from the old path into the new, presents in his own writings one of the most striking examples of the evil he did so much to destroy.

The Novum Organon, considering the time when it came from his pen, is doubtless one of the greatest exhibitions of genius in the history of human thought. It showed the modern world the way out of the scholastic method and reverence for dogma into the experimental method and reverence for fact. In it occur many passages which show that the great philosopher was fully alive to the danger both to religion and to science arising from their mixture. He declares that the "corruption of philosophy from superstition and theology introduced the greatest amount of

---

possibilities of God assuming forms of stone, or log, or beast, see Lippert, Christenthum, Volksglaube, und Volksbrauch, pp. 372, 373, where citations are given, etc. For the syllogism regarding Solomon, see Figuier, L'Alchemie et les Alchemistes, pp. 106, 107. For careful appreciation of Becher's position in the history of chemistry, see Kopp, Ansichten über die Aufgabe der Chemie, etc., von Geber bis Stahl, Braunschweig, 1875, pp. 201 *et seq.* For the text proving the existence of the philosopher's stone from the book of Revelation, see Figuier, p. 22.

* For Melanchthon's ideas on physics, see his Initia Doctrinæ Physicæ, Wittenberg, 1557, especially pp. 243 and 274; also in vol. xiii of Bretschneider's edition of the collected works, and especially pp. 339–343.

evil both into whole systems of philosophy and into their parts." He denounces those who "have endeavored to found a natural philosophy on the books of Genesis and Job and other sacred Scriptures, so 'seeking the dead among the living.'" He speaks of the result as "an unwholesome mixture of things, human and divine; not merely fantastic philosophy, but heretical religion." He refers to the opposition of the fathers to the doctrine of the rotundity of the earth, and says that "thanks to some of them, you may find the approach to any kind of philosophy, however improved, entirely closed up." He charges that some of these divines are "afraid lest perhaps a deeper inquiry into Nature should penetrate beyond the allowed limits of sobriety"; and finally speaks of theologians as sometimes craftily conjecturing that if science be little understood, "each single thing can be referred more easily to the hand and rod of God," and says, "*This is nothing more nor less than wishing to please God by a lie.*"

No man who has reflected much upon the annals of his race can, without a feeling of awe, come into the presence of such clearness of insight and boldness of utterance, and the first thought of the reader is, that of all men Francis Bacon is the most free from the unfortunate bias he condemns; that he, certainly, can not be deluded into the old path. But as we go on through his main work we are surprised to find that the strong arm of Aquinas has been stretched over the intervening ages, and has laid hold upon this master-thinker of the seventeenth century. For only a few chapters beyond those containing the citations already made we find Bacon alluding to the recent voyage of Columbus, and speaking of the prophecy of Daniel regarding the latter days, that "many shall run to and fro and knowledge be increased," as clearly signifying "that . . . the circumnavigation of the world and the increase of science should happen in the same age." *

In his great work on the Advancement of Learning the firm grasp which the methods he condemned held upon him is shown yet more clearly. In the first book of it he asserts "that excellent book of Job, if it be revolved with diligence, will be found pregnant and swelling with natural philosophy," and he endeavors to show that in it the "roundness of the earth," the "fixing of the stars, ever standing at equal distances," the "depression of the southern pole," the "matter of generation," and "matter of minerals" are "with great elegancy noted." But, curiously enough, he uses to support some of these truths the very texts which the fathers of the Church used to destroy them, and those for which

* See the Novum Organon, translated by the Rev. G. W. Kitchin, Oxford, 1855, chaps. lxv and lxxxix.

he finds Scripture warrant most clearly are such as science has since disproved. So, too, he says that Solomon was enabled in his Proverbs, "by donation of God, to compile a natural history of all verdure."*

We have now seen how powerless were the strongest men in physical science, singly, in this struggle against theology and ecclesiasticism, and it may be well to study briefly their efforts after they had learned to combine in societies and academies against the common enemy. In the latter half of the sixteenth century, John Baptist Porta began his investigations, and despite much absurdity they were fruitful. His was not "black magic," claiming the aid of Satan, but "white magic" bringing into service the laws of Nature—the precursor of applied science. His book on Meteorology was the first in which sound ideas were broached on that subject; his researches in optics gave the world the camera obscura, and possibly the telescope; in chemistry he seems to have been the first to show how to reduce the metallic oxides, and thus to have laid the foundation of all those industries based upon the coloring and staining of glass and enamels; he did much to change natural philosophy from a "black art" to a vigorous open science. He encountered the old policy of conscientious men; the society founded by him for physical research, "I Secreti," was broken up, and he was summoned to Rome by Pope Paul III and forbidden to continue his investigations.

In 1624 some young chemists of Paris, having taught the experimental method and cut loose from Aristotle, the Faculty of Theology beset the Parliament of Paris, and the Parliament prohibited this new chemical teaching, under penalty of death.

The same war continued in Italy. In 1657 occurred the first sitting of the Accademia del Cimento at Florence, under the presidency of Prince Leopold dei Medici. This Academy promised great things for science; it was open to all talent; its only fundamental law was "the repudiation of any favorite system or sect of philosophy, and the obligation to investigate Nature by the pure light of experiment"; it entered into scientific investigations with energy. Borelli in mathematics, Redi in natural history, and many others pushed on the boundaries of knowledge. Heat, light, magnetism, electricity, projectiles, digestion, the in-

* See Bacon, Advancement of Learning, edited by W. Aldis Wright, London, 1873, pp. 47, 48. Certainly no more striking examples of the strength of the evil which he had all along been denouncing could be exhibited than these in his own writings. Nothing better illustrates the sway of the mediæval theology, or better explains his blindness to the discoveries of Copernicus and to the experiments of Gilbert. For a very contemptuous statement of Lord Bacon's claim to his position as a philosopher, see Lange, Geschichte des Materialismus, Leipsic, 1874, vol. i, p. 219. For a more just statement, see Brewster, Life of Sir Isaac Newton. See, also Jevons, Principles of Science, London, 1874, vol. ii, p. 298.

compressibility of water, were studied by the right method and with results that enriched the world.

The Academy was a fortress of science, and siege was soon laid to it. The votaries of scholastic learning denounced it as irreligious; quarrels were fomented; Leopold was bribed with a cardinal's hat and drawn away to Rome; and, after ten years of beleaguering, the fortress fell: Borelli was left a beggar; Oliva killed himself in despair.

So, too, the noted Academy of the Lincei at times incurred the ill-will of the papacy by the very fact that it included thoughtful investigators. It was "patronized" by Pope Urban VIII in such manner as to paralyze it, and it was afterward vexed by Pope Gregory XVI; even in our own time sessions of scientific associations were discouraged and thwarted by Pope Pius IX.*

Such was the struggle of the physical sciences in general. Let us now look briefly at one special example out of many, which reveals, as well as any, the beginning, continuance, and end of theological interference with the evolution of them.

It will doubtless seem amazing to many that for ages the weight of theological thought in Christendom was thrown against the idea of the suffocating properties of certain gases, and especially of carbonic acid. Although in antiquity we see men forming a right theory of gases in mines, we find that, early in the history of the Church, St. Clement of Alexandria put forth the theory that these gases are manifestations of diabolic action, and that, throughout Christendom, suffocation in caverns, wells, and cellars was attributed to the direct action of evil spirits. Evidences of this view abound through the mediæval period, and even as late as the Reformation period a great authority, Agri-

---

* For Porta, see the English translation of his main summary, "Natural Magick," London, 1658. The first chapters are especially interesting, as showing what the word "magic" had come to mean in the mind of a man in whom mediæval and modern ideas were curiously mixed; see also Hoefer, Histoire de la Chimie, vol. ii, pp. 102–106; also Kopp; also Sprengel, Histoire de la Médecine, iii, p. 239; also Musset-Pathay. For the Accademia del Cimento, see Napier, Florentine History, vol. v, p. 485; Tiraboschi, Storia della Litteratura; Henri Martin, Histoire de France; Jevons, Principles of Science, vol. ii, pp. 36–40. For value attached to Borelli's investigations by Newton and Huygens, see Brewster's Life of Sir Isaac Newton, London, 1875, pp. 128, 129. Libri, in his Essai sur Galilée, p. 37, says that Oliva was summoned to Rome and so tortured by the Inquisition that, to escape further cruelty, he ended his life by throwing himself from a window. For interference by Pope Gregory XVI with the Academy of the Lincei, and with public instruction generally, see Carutti, Storia della Accademia dei Lincei, p. 126. Pius IX, with all his geniality, seems to have allowed his hostility to voluntary associations to carry him very far at times. For his answer to an application made through Lord Odo Russell regarding a society for the prevention of cruelty to animals and his answer that "such an association could not be sanctioned by the Holy See, being founded on a theological error, to wit, that Christians owed any duties to animals," see Frances Power Cobbe, Hopes of the Human Race, p. 207.

cola, one of the most earnest and truthful of investigators, still adheres to the belief that these gases in mines are manifestations of devils, and specifies two classes—one of malignant imps, who blow out the miners' lamps, and the other of friendly imps, who simply tease the workmen in various ways. He goes so far as to tell us that one of these spirits in the Saxon mine of Annaberg destroyed twelve workmen at once by the power of his breath.

At the end of the sixteenth century we find a writer on mineralogy complaining that the mines in France and Germany had been in large part abandoned on account of the "evil spirits of metals which had taken possession of them."

But at various periods glimpses of the truth had been gained. The ancient view had not been entirely forgotten; and as far back as the first part of the thirteenth century Albert the Great suggested a natural cause in the possibility of exhalations from minerals causing a "corruption of the air"; but he, as we have seen, was driven or dragged off into theological studies, and the world relapsed into the theological view.

Toward the end of the fifteenth century there came a great genius laden with important truths in chemistry, but for whom the world was not ready—Basil Valentine. His discoveries anticipated much that has brought fame and fortune to chemists since, yet so fearful of danger was he that his work was carefully concealed. Not until after his death was his treatise on alchemy found, and even then it was for a long time not known where and when he lived. The papal bull, *Spondent pariter*, and the various prohibitions it bred, forcing other alchemists to conceal their laboratories, led him to let himself be known during his life at Erfurt simply as an apothecary, and to wait until after his death to make a revelation of truth, which during his lifetime might have cost him dear. Among the legacies of this greatest of the alchemists was the doctrine that the air which asphyxiates workers in mines is similar to that which is produced by fermentation of malt, and a recommendation that in order to drive away the evil and to prevent serious accidents, fires be lighted and jets of steam used to ventilate the mines, laying stress especially upon the idea that the danger in the mines is produced by "exhalations of metals."

Thanks to men like Valentine, this idea of the interference of Satan and his minions with the mining industry was gradually weakened, and the working of the deserted mines was resumed; yet, even at a comparatively recent period, we find it still lingering, and among leading divines in the very heart of Protestant Germany. In 1715 a cellar-digger having been stifled at Jena, the medical faculty of the university decided that the cause was not the direct action of the devil, but a deadly gas. Thereupon

Prof. Loescher, of the University of Wittenberg, entered a solemn protest, declaring that the decision of the medical faculty was "only a proof of the lamentable license which has so taken possession of us, and which, if we are not earnestly on our guard, will finally turn away from us the blessing of God."* But denunciations of this kind could not hold back the little army of science. In the last half of the eighteenth century Black, Priestley, and especially Bergmann, rooted out the very foundations of the whole theologic theory, and one more phantom which had long troubled the earth was at last driven forth forever.†

Thus, in spite of adverse influences, the evolution of the physical sciences went on. More and more there rose men bold enough to break away from the theological method, and strong enough to resist the enticements or threats of ecclesiasticism. Alchemy in its first form, seeking for the philosopher's stone and the transmutation of metals, gave way to alchemy in its second form, seeking for the elixir of life and remedies more or less magical for disease; and this in turn yielded to the search for truth as truth. More and more the "solemnly constituted impostors" were resisted in every field. A great line of physicists and chemists began to appear. Though theological modes of reasoning continued to sterilize much effort in chemistry down to our own century, more and more the old influence was thrown off; more and more truth was sought as truth; less and less science was bent to aid in the alleged "saving of souls." "Black magic" with its satanic apparatus vanished, only reappearing occasionally among miracle-mongers and belated theologians. "White magic" became legerdemain.‡

In our own time some attempt has been made to renew this war against the physical sciences. Joseph de Maistre, uttering his hatred of them, declaring that mankind has paid too dearly for them, asserting that they must be subjected to theology, likening them to fire—good when confined and dangerous when scattered about—has been one of the main leaders among those who can not relinquish the idea that our body of sacred literature should be kept a controlling text-book of science. The only effect

* For Loescher's protest, see Julian Schmidt, Geschichte des geistigen Lebens, etc., vol. i, p. 319.

† For the general view of noxious gases as imps of Satan, see Hoefer, Histoire de la Chimie, vol. i, p. 350, vol. ii, p. 48. For the work of Black, Priestley, Bergmann, and others, see main authorities already cited, and especially the admirable paper of Dr. R. G. Eccles on The Evolution of Chemistry, New York, D. Appleton & Co., 1891.

‡ For a reappearance of the fundamental doctrine of black magic among theologians, see Rev. Dr. Jewett, Professor of Pastoral Theology in the Prot. Episc. Gen. Theolog. Seminary of New York, Diabolology: The Person and Kingdom of Satan, New York, 1889. For their reappearance among theosophists, see Elephas Levi, Histoire de la Magie, especially the final chapters.

of such teachings has been to weaken the legitimate hold of religion upon men.

In Catholic countries the effort has been of late years mainly confined to excluding science or diluting it in university teachings. Early in the present century a great effort was made by Ferdinand VII of Spain. He simply dismissed the scientific professors from the University of Salamanca, and until a recent period there has been general exclusion from Spanish universities of professors holding to the Newtonian physics. So, too, the contemporary Emperor of Austria attempted indirectly something of the same sort; and at a still later period Popes Gregory XVI and Pius IX discouraged, if they did not forbid, the meetings of scientific associations in Italy. In France, war between theology and science, which had long been smoldering, came in the years 1867 and 1868 to an outbreak. Toward the end of the last century, after the Church had held possession of advanced instruction for more than a thousand years, and had, so far as it was able, kept experimental science in servitude—after it had humiliated Buffon in natural science, thrown its weight against Newton in the physical sciences, and wrecked Turgot's noble plans for a system of public instruction—the French nation decreed the establishment of the most thorough and complete system of higher instruction in science ever known. It was kept under lay control, and became one of the glories of France; but, emboldened by the restoration of the Bourbons in 1815, the Church began to undermine this hated system, and in 1868 had made such progress that all was ready for the final assault.

Foremost among the leaders of the besieging party was the Bishop of Orleans, Dupanloup, a man of many winning characteristics and of great oratorical power. In various ways, and especially in an open letter, he had fought the "materialism" of science at Paris, and especially were his attacks leveled at Profs. Vulpian and Sée, and the Minister of Public Instruction, Duruy, a man of great merit, whose only crime was devotion to the improvement of education, and to the promotion of the highest research in science.*

The main attack was made rather upon biological science than upon physics and chemistry, yet it was clear that all were involved together.

The first onslaught was made in the French Senate, and the storming party in that body was led by a venerable and conscientious prelate, Cardinal de Bonnechose, Archbishop of Rouen. It was charged by him and his party that the tendencies of the higher scientific teaching at Paris were fatal to religion and mo-

* For Dupanloup, Lettre à un Cardinal, see the Revue de Thérapeutique of 1868, p. 221.

rality. Heavy missiles were hurled—such phrases as "sapping the foundations," etc., "breaking down the bulwarks," etc., and, withal, a new missile was used with much effect—the epithet "materialist."

The results can be easily guessed: crowds came to the lecture-rooms of the attacked professors, and the lecture-room of Prof. Sée, the chief offender, was crowded to suffocation.

A siege was begun in due form. A young physician was sent by the cardinal's party into the heterodox camp as a spy. Having heard one lecture of Prof. Sée, he returned with information that seemed to promise easy victory to the besieging party; he brought a terrible statement—one that seemed enough to overwhelm Sée, Vulpian, Duruy, and the whole hated system of public instruction in France—the statement that Sée had denied the existence of the human soul.

Good Cardinal Bonnechose seized the tremendous weapon. Rising in his place in the Senate, he launched a most eloquent invective against the Minister of State who could protect such a fortress of impiety as the College of Medicine; and, as a climax, he asserted, on the evidence of his spy fresh from Prof. Sée's lecture-room, that the professor had declared, in his lecture of the day before, that so long as he had the honor to hold his professorship he would combat the false idea of the existence of the soul. The weapon seemed resistless, and the wound fatal; but M. Duruy rose and asked to be heard.

His statement was simply that he held in his hand documentary proofs that Prof. Sée never made such a declaration. He held the notes used by Prof. Sée in his lecture. Prof. Sée, it appeared, belonged to a school in medical science which combated certain ideas regarding medicine as an *art*. The inflamed imagination of the cardinal's heresy-hunting emissary had, as the lecture notes proved, led him to mistake the word *"art"* for *"âme"* and to exhibit Prof. Sée as treating a theological when he was discussing a purely scientific question. Of the existence of the soul the professor had said nothing.

The forces of the enemy were immediately turned; they retreated in confusion, amid the laughter of all France; and a quiet, dignified statement as to the rights of scientific instructors by Wurtz, Dean of the Faculty, completed their discomfiture. Thus a well-meant attempt to check science simply ended in bringing ridicule on religion, and thrusting still deeper into the minds of thousands of men that most mistaken of all mistaken ideas—the conviction that religion and science are enemies.*

---

* For a general account of the Vulpian and Sée matter, see Revue des Deux Mondes, 31 mai, 1868; Chronique de la Quinzaine, pp. 763–765. As to the result on popular thought,

But justice forbids raising an outcry against Roman Catholicism alone for this. In 1864 a number of excellent men in England drew up a declaration to be signed by students in the natural sciences, expressing "sincere regret that researches into scientific truth are perverted by some in our time into occasion for casting doubt upon the truth and authenticity of the Holy Scriptures." Nine tenths of the leading scientific men of England refused to sign it; nor was this all: Sir John Herschel, Sir John Bowring, and Sir W. R. Hamilton administered, through the press, castigations which roused general indignation against the proposers of the circular, and Prof. De Morgan, by a parody, covered memorial and memorialists with ridicule. It was the old mistake, and the old result followed in the minds of multitudes of thoughtful young men.*

And in yet another Protestant country this same mistake was made. In 1868 several excellent churchmen in Prussia thought it their duty to meet for the denunciation of "science falsely so called." Two results followed: upon the great majority of these really self-sacrificing men—whose first utterances showed complete ignorance of the theories they attacked—there came quiet and wide-spread contempt; upon Pastor Knak, who stood forth and proclaimed views of the universe which he thought scriptural, but which most school-boys knew to be childish, came a burst of good-natured derision from every quarter of the German nation.†

Warfare of this sort against science seems petty indeed; but it is to be guarded against in Protestant countries not less than in Catholic; it breaks out in America not less than in Europe. Do conscientious Roman bishops in France labor to keep all advanced scientific instruction under their own control—in their own universities and colleges; so do many not less conscientious Protestant clergymen in our own country insist that advanced education in science and literature shall be kept under control in their own sectarian universities and colleges, wretchedly one-sided in their development, and miserably inadequate in their equipment: did a leading Spanish university, until a recent period, exclude professors holding the Newtonian theory; so have many leading American colleges excluded professors holding the Darwinian theory: have Catholic colleges in Italy rejected excellent candidates for professorships on account of "unsafe" views regarding

---

may be noted the following comment on the affair by the Revue, which is as free as possible from anything like rabid anti-ecclesiastical ideas: "Elle a été vraiment curieuse, instructive, assez triste et même un peu amusante." For Wurtz's statement, see Revue de Thérapeutique for 1868, p. 303.

* De Morgan, Paradoxes, pp. 421–428; also, Daubeny's Essays.

† See the Berlin newspapers for the summer of 1868, especially Kladderadatsch.

the immaculate conception; so have Protestant colleges in America frequently rejected excellent candidates on account of "unsafe" views regarding the apostolic succession, or the incarnation, or baptism, or the perseverance of the saints.

And how has all this system resulted? In the older nations, by natural reaction, these colleges, under strict ecclesiastical control, have sent forth the most bitter enemies the Christian Church has ever known—of whom Voltaire and Renan and Saint-Beuve are types; and there are many signs that the same causes are to produce the same results in our own country.

I might allude to other battle-fields in our own land and time. I might show how, twenty years ago, attempts to meet the want in a great American State of an institution providing higher scientific instruction, were met with loud outcries from many excellent men, who feared injury thereby to religion; and how in various other States, at various times since, the same feeling has been shown. Happily, leading men at the centers of Christian thought in many countries are now taking a larger and better view: but I again point to the recent driving out of the Darwinian professors from the American college at Beirut, under the direction of American Protestants, as an evidence that the old spirit still exists; no longer, indeed, seriously injurious to science, but deeply injurious to religion.*

It was the purpose of Prof. Max Müller's inaugural address as President of the International Oriental Congress to show that the break that now appears in the continuity of thought between the East and West did not exist from the beginning, and that in prehistoric times language really formed a bond of union between the ancestors of many of the Eastern and Western nations; and that more recent discoveries have proved that, in historic times also, language, which seemed to separate the great nations of antiquity, never so completely separated the most important among them as to make intellectual commerce and exchange among them impossible. To have established these two facts, Prof. Müller claims, constitutes one of the greatest achievements and highest glories of Oriental scholarship.

---

* It is an interesting fact that one of the men thus driven out of the American college at Beirut, for supposed adhesion to the doctrines of Darwin, has since become one of the most influential editors at Cairo, carrying on a daily journal and two periodicals, and exercising a far greater and wider influence upon thought in the East than ever before. Whatever may be thought of the system of philosophy advocated by President McCosh at Princeton, every thinking man must honor him for the large way in which he, at least, broke away from the traditions of that center of thought; prevented, so far as he was able, persecution of scholars for holding to the Darwinian view; and paved the way for the highest researches in physical science in that university. For a most eloquent statement of the opposition of modern physical science to mediæval theological views, as shown in the case of Sir Isaac Newton, see Dr. Thomas Chalmers, cited in Gore, Art of Scientific Discovery, London, 1878, p. 247.

THE STUDY OF MAN.*

By ALEXANDER MACALISTER, M. D., F. R. S.

ON an irregular and unfenced patch of waste land, situated on the outskirts of a small town in which I spent part of my boyhood, there stood a notice board bearing the inscription, "A Free Coup," which, when translated into the language of the southron, conveyed the intimation, "Rubbish may be shot here." This place, with its ragged mounds of unconsidered trifles, the refuse of the surrounding households, was the favorite playground of the children of the neighborhood, who found a treasury of toys in the broken tiles and oyster-shells, the crockery and cabbage-stalks, which were liberally scattered around. Many a make-believe house and road, and even village, was constructed by these mimic builders out of this varied material, which their busy little feet had trodden down until its undulated surface assumed a fairly coherent consistence.

Passing by this place ten years later I found that its aspect had changed; terraces of small houses had sprung up, mushroom-like, on the unsavory foundation of heterogeneous refuse. Still more recently I notice that these in their turn have been swept away, and now a large factory, wherein some of the most ingenious productions of human skill are constructed, occupies the site of the original waste.

This commonplace history is, in a sense, a parable in which is set forth the past, present, and possible future of that accumulation of lore in reference to humanity to which is given the name Anthropology, and for the study of which this section of our Association is set apart. At first nothing better than a heap of heterogeneous facts and fancies, the leavings of the historian, of the adventurer, of the missionary, it has been for long, and alas is still, the favorite playground of *dilettanti* of various degrees of seriousness. But upon this foundation there is rapidly rising a more comely superstructure, fairer to see than the original chaos, but still bearing marks of transitoriness and imperfection, and I dare hazard the prediction that this is destined in the course of time to give place to the more solid fabric of a real science of anthropology.

We cannot yet claim that our subject is a real science in the sense in which that name is applied to those branches of knowledge, founded upon ascertained laws, which form the subjects of most of our sister sections; but we can justify our separate exist-

* Vice-presidential address before the Section of Anthropology of the British Association for the Advancement of Science.

ence, in that we are honestly endeavoring to lay a definite and stable foundation, upon which in time to come a scientific anthropology may be based.

The materials with which we have to do are fully as varied as were those in my illustration, for we as anthropologists take for our motto the sentiment of Chremes, so often quoted in this section, *humani nihil a nobis alienum putamus* (we think nothing human foreign to us), and they are too often fully as fragmentary. The bones, weapons, and pottery which form our only sources of knowledge concerning prehistoric races of men, generally come to us as much altered from their original forms as are the rusty polyhedra which once were the receptacles of biscuits or sardines. The traditions, customs, and scraps of folk lore which are treasures to the constructive anthropologist, are usually discovered as empty shells, in form as much altered from their original conditions as are those smooth fragments of hollow white cylinders which once held the delicate products of the factory of Keiller or Cairns.

I have said that anthropology has not yet made good its title to be ranked as an independent science. This is indicated by the difficulty of framing a definition at the same time comprehensive and distinctive. Mr. Galton characterizes it as the study of what men are in body and mind, how they came to be what they are, and whither the race is tending; General Pitt-Rivers, as the science which ascertains the true causes for all the phenomena of human life. I shall not try to improve upon these definitions, although they both are manifestly defective. On the one side our subject is a branch of biology, but we are more than biologists compiling a monograph on the natural history of our species, as M. de Quatrefages would have it. Many of the problems with which we deal are common to us and to psychologists; others are common to us and to students of history, of sociology, of philology, and of religion; and, in addition, we have to treat of a large number of other matters æsthetic, artistic, and technical, which it is difficult to range under any subordinate category.

In view of the encyclopedic range of knowledge necessary for the equipment of an accomplished anthropologist, it is little wonder that we should be, as we indeed are, little better than smatterers. Its many-sided affinities, its want of definite limitation, and the recent date of its admission to the position of an independent branch of knowledge, have hitherto caused anthropology to fare badly in our universities. In this respect, however, we are improving, and now in the two great English universities there are departments for the study of the natural history of man and of his works.

Out of the great assemblage of topics which come within our

sphere, I can only select a few which seem at present to demand special consideration. The annual growth of our knowledge is chiefly in matters of detail which are dull to chronicle, and the past year has not been fertile in discoveries bearing on those great questions which are of popular interest.

On the subject of the antiquity of man there are no fresh discoveries of serious importance to record. My esteemed predecessor at the Leeds meeting two years ago, after reviewing the evidence as to the earliest traces of humanity, concluded his survey with the judgment, "On the whole, therefore, it appears to me that the present verdict as to Tertiary man must be in the form of 'Not proven.'" Subsequent research has not contributed any new facts which lead us to modify that finding. The most remarkable of the recent discoveries under this head is that of the rude implements of the Kentish chalk-plateau described by Prof. Prestwich; but while these are evidently of archaic types, it must be admitted that there is even yet room for difference of opinion as to their exact geological age.

Neither has the past year's record shed new light on the darkness which enshrouds the origin of man. What the future may have in store for us in the way of discovery we can not forecast; at present we have nothing but hypothesis, and we must still wait for further knowledge with the calmness of philosophic expectancy.

I may, however, in this connection refer to the singularly interesting observations of Dr. Louis Robinson on the prehensile power of the hands of children at birth, and to the graphic pictures with which he has illustrated his paper. Dr. Robinson has drawn, from the study of the one end of life, the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather, that there still survive in the human structure and habit traces of our probably arboreal ancestry.

Turning from these unsolved riddles of the past to the survey of mankind as it appears to us in the present, we are confronted in that wide range of outlook with many problems well-nigh as difficult and obscure.

Mankind, whenever and however it may have originated, appears to us at present as an assemblage of tribes, each not necessarily homogeneous, as their component elements may be derived from diverse genealogical lines of descent. It is much to be regretted that there is not in our literature a more definite nomenclature for these divisions of mankind, and that such words as *race, people, nationality, tribe,* and *type* are often used indiscriminately as though they were synonyms.

In the great mass of knowledge with which we deal there are several collateral series of facts, the terminologies of which should

be discriminated. In the first place there are those ethnic conditions existing now, or at any other point in time, whereby the individuals of mankind are grouped into categories of different comprehension, as *clans* or families, as *tribes* or groups of allied clans, and as *nations*, the inhabitants of restricted areas under one political organization. This side of our subject constitutes ethnology.

In the second place, the individuals of mankind may be regarded as the descendants of a limited number of original parents, and consequently each person has his place on the genealogical tree of humanity. As the successive branches became in their dispersion subjected to the influences of diverse environments, they have eventually differentiated in characteristics. To each of these subdivisions of the phylum thus differentiated the name *race* may appropriately be restricted, and the sum of the peculiarities of each race may be termed *race-characters*. This is the phylogenetic* side of anthropology, and its nomenclature should be kept clearly separate from that of the ethnological side. The great and growing literature of anthropology consists largely of the records of attempts to discover and formulate these distinctive race-characters. *Race* and *tribe* may be terms of equal extension, but the standpoint from which these categories are viewed is essentially different in the two cases.

There is yet a third series of names in common use in descriptive anthropology. The languages in use among men are unfortunately numerous, and as the component individuals in each community usually speak a common language, the mistake is often made of confounding the tribal name with that of the tribal language. Sometimes these categories are coextensive; but it is not always so, for it is a matter of history that communities have been led to adopt new languages from considerations quite independent of phylogenetic or ethnic conditions. These linguistic terms should not be confounded with the names in either of the other series, for, as my learned predecessor once said in a presidential address, it is as absurd to speak of an Aryan skull as it would be to say that a family spoke a brachycephalic language.

In the one clan there may be, by intermarriage, the representatives of different races; in the one nation there may be dissimilar tribes, each derived by composite lines of ancestry from divergent phyla, yet all speaking the same language.

We have an excellent illustration of the confusion resulting from this disregard of precision in the case of the word *Celtic*, a term which has sometimes been employed as an ethnic, sometimes

---

* Pertaining to lines of descent.

as a phylogenetic, and sometimes as a linguistic species. In the last-named sense, that to which I believe the use of the name should be restricted, it is the appropriate designation of a group of cognate languages spoken by peoples whose physical characters show that they are not the descendants of one common phylum in the near past. There are fair-haired, long-headed families in Scotland and Ireland; fair, broad-headed Bretons; dark-haired, round-headed Welshmen; and dark-haired, long-headed people in the outer Hebrides, McLeans, "Sancho Panza type"—men obviously of different races, who differ not only in color, stature, and skull-form, but whose traditions also point to a composite descent, and yet all originally speaking a Celtic tongue. The use of the word *Celtic*, as if it were the name of a phylogenetic species, has naturally led to hopeless confusion in the attempts to formulate race-characters for the Celtic skull—confusions of a kind which tend to bring physical anthropology into discredit. Thus Retzius characterizes the Celtic crania as being dolichocephalic, and compares them with those of the modern Scandinavians. Sir Daniel Wilson considers the true Celtic type of skull as intermediate between the dolichocephalic and the brachycephali; and Topinard figures as the typical Celtic skull that of an Auvergnat, extremely brachycephalic, with an index of 85!

Our traditional history tells that we, the Celtic-speaking races of Britain, are not of one common ancestry, but are the descendants of two distinct series of immigrants, a British and a Gaelic. Whatever may have been the origin of the former, we know that the latter are not homogenous, but are the mixed descendants of the several Fomorian, Nemedian, Firbolg, Tuatha de Danaan, and Milesian immigrations, with which has been combined in later times a strong admixture of Scandinavian blood. It is now scarcely possible to ascertain to which of these component strains in our ancestry we owe the Celtic tongue which overmastered and supplanted the languages of the other tribes, but it is strictly in accordance with what we know of the history of mankind, that this change should have taken place. We have instances in modern times of the adoption by conquered tribes of the language of a dominant invading people. For example, Mr. Hale has lately told us that the speech of the Hupas has superseded the languages of those Californian Indians whom they have subdued. In like manner, nearer home, the English language is slowly but surely supplanting the Celtic tongues themselves.

We may here parenthetically note that what has been observed in the case of language has also taken place in reference to ritual and custom. Observances which have a history and a meaning for one race have, in not a few instances, been adopted by or im-

posed upon other races to whom they have no such significance, and who in incorporating them give to them a new local color. These pseudomorphs of the earlier cultures are among the most perplexing of the problems which the student of comparative religion or folk lore has to resolve.

But we want more than a perfect nomenclature to bring anthropology into range with the true sciences. We need a broader basis of ascertained fact for inductive reasoning in almost all parts of our subject; we want men trained in exact method who will work patiently at the accumulation, verification, and sorting of facts, and who will not prematurely rush into theory. We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work.

The present position of our subject is critical and peculiar: while on the one hand the facilities for anthropological research are daily growing greater, yet in some directions the material is diminishing in quantity and accessibility. We are accumulating in our museums treasures both of the structure and the works of man, classified according to his distribution in time and space; but at the same time some of the most interesting tribes have vanished, and others are rapidly disappearing or becoming fused with their neighbors. As these pass out of existence we, with them, have lost their thoughts, their tongues, and their traditions; for even when they survive, blended with other races, that which was a religion has become a fragmentary superstition, then a nursery tale or a child's game, and is destined finally to be buried in oblivion. The unifying influences of commerce, aided by steam and electricity, are effectually effacing the landmarks between people and people, so that if we are to preserve in a form fit for future use the shreds which remain of the myths, folk lore, and linguistic usages of many of the tribes of humanity, we must be up and doing without delay. It is on this account that systematic research such as that which Mr. Risley has advocated with regard to the different races of India is of such pressing and urgent importance. It is for this reason, likewise, that we hail with pleasure the gathering of folk lore while yet it survives, and welcome such societies for the purpose as the Folk-lore Congress recently inaugurated.

I have said that in the department of physical anthropology our facilities for research are increasing. The newly founded anthropometric laboratories are beginning to bring forth results in the form of carefully compiled statistical tables, embodying the fruits of accurate observations, which are useful as far as they go. Were these extended in their scope the same machinery might easily gather particulars as to the physical characters of

the inhabitants of different districts, which would enable the anthropologist to complete in a systematic manner the work which Dr. Beddoe had so well begun. I would commend this work to the consideration of the provincial university colleges, especially those in outlying districts.

Of all the parts of the human frame, the skull is that upon which anthropologists have in the past expended the most of their time and thought. We have now, in Great Britain alone, at least four collections of skulls, each of which includes more than a thousand specimens, and in the other great national and university museums of Europe there are large collections available for study and comparison.

Despite all the labor that has been bestowed on the subject, craniometric literature is at present as unsatisfactory as it is dull. Hitherto observations have been concentrated on cranial measurements as methods for the discrimination of the skulls of different races. Scores of lines, arcs, chords, and indexes have been devised for this purpose, and the diagnosis of skulls has been attempted by a process as mechanical as that whereby we identify certain issues of postage-stamps by counting the nicks in the margin. But there is underlying all these no unifying hypothesis; so that when we in our sesquipedalian jargon describe an Australian skull as microcephalic, phænozygous, tapeino-dolichocephalic, prognathic, platyrhine, hypselopalatine, leptostaphyline, dolichuranic, chamæprosopic, and microseme, we are no nearer to the formulation of any philosophic concept of the general principles which have led to the assumption of these characters by the cranium in question, and we are forced to echo the apostrophe of Von Török, "Vanity, thy name is Craniology."

It was perhaps needful in the early days of the subject that it should pass through the merely descriptive stage; but the time has come when we should seek for something better, when we should regard the skull not as a whole complete in itself, nor as a crystalline geometrical solid, nor as an invariable structure, but as a marvelously plastic part of the human frame, whose form depends on the co-operation of influences, the respective shares of which in molding the head are capable of qualitative if not of quantitative analysis. Could measurements be devised which would indicate the nature and amounts of these several influences, then, indeed, would craniometry pass from its present empirical condition, and become a genuine scientific method. We are yet far from the prospect of such an ideal system, and all practical men will realize the immense, but not insuperable, difficulties in the way of its formulation.

In illustration of the profound complexity of the problem which the craniologist has to face, I would ask your indulgence

while I set out a few details to show the several factors whose influence should be numerically indicated by such a mode of measurement.

The parts composing the skull may be resolved into four sets: there is, first, the brain-case; secondly, the parts which subserve mastication and the preparation of the food for digestion; thirdly, the cavities containing the organs of the senses of hearing, sight, and smell; and, fourthly, those connected with the production of articulate speech. If our measurements are to mean anything, they should give us a series of definite numbers indicating the forms, modifications, and relative size of these parts, and their settings with regard to each other and to the rest of the body.

To take the last point first, it needs but a small consideration to show that the parts of the skull are arranged above and below a certain horizontal plane, which is definite (although not easily ascertained) in every skull, human or animal. This is the plane of vision. The familiar lines of Ovid—

> "Pronaque cum spectent animalia cetera terram,
> Os homini sublime dedit; cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus"*—

are anatomically untrue, for the normal quadruped and man alike, in their most natural position, have their axis of vision directed to the horizon. Systems of measurement based upon any plane other than this are essentially artificial. There are at the outset difficulties in marking the plane accurately on the skull, and it is to be deplored that the anthropologists of different nations should have allowed themselves to be affected by extraneous influences, which have hindered their unanimous agreement upon some one definite horizontal plane in craniometry.

The Frankfort plane, drawn through the upper margins of the auditory foramina and the lowest points of the orbital borders, has the advantage of being easily traced, and differs so little from the plane of vision that we may without substantial error adopt it.

The largest part of the skull is that which is at once the receptacle and the protector of the brain, a part which, when unmodified by external pressure, premature synostosis, or other adventitious conditions, owes its form to that of the cerebral hemispheres which it contains. Speaking in this city of George and Andrew Combe, I need not do more than indicate in this matter that observation and experiment have established on a firm basis certain fundamental points regarding the growth of the brain. The

* While other animals look down upon the earth, he has given an upward face to man; and has ordered him to look at the sky and to raise his eyes to the stars.

study of its development shows that the convolutioning of the cerebral hemisphere is primarily due to the connection, and different rate of growth, of the superficial layer of cells with the underlying layers of white nerve fibers; and that so far from the shape being seriously modified by the constraining influence of the surrounding embryonic skull, the form of the soft membranous brain-case is primarily molded upon the brain within it, whose shape it may however be, to some extent, a secondary agent in modifying in later growth. We have also learned that, although in another sense from that of the crude phrenology of Aristotle, Porta, or Gall, the cerebrum is not a single organ acting as a functional unit, but consists of parts, each of which has its specific province; that the increase in the number of cells in any area is correlated with an increase in the size and complexity of pattern of the convolutions of that area; and that this in turn influences the shape of the inclosing shell of membrane and subsequently of bone.

The anatomist and the physiologist have worked hand in hand in the delimitation of these several functional areas, and pathology and surgery have confirmed what experimental physiology has taught. The topography of each part of the cerebrum, so important to the operating surgeon, should be pressed into the service of the anthropologist, whose measurements of the brain-case should have definite relation to these several areas. In the discussion which is to take place on this subject, I hope that some such relationships will be taken account of. This is not the place to work out in detail how this may be done; I only desire to emphasize the fundamental principle of the method.

The second factor which determines the shape of the individual skull is the size of the teeth. That these differ among different races is a matter of common observation; thus the average area of the crowns of the upper-jaw teeth in the male Australian is 1,536 sq. mm., while in the average Englishman it is only 1,286 sq. mm., less than 84 per cent of that size.*

It is easy to understand how natural selection will tend to increase the size of the teeth among those races whose modes of feeding are not aided by the cook or the cutler; and how, on the other hand, the progress of civilized habits, assisted by the craft of the dentist, interferes with the action of selection in this matter among the more cultured races.

For larger teeth a more extensive alveolar arch of implantation is necessary; and as the two jaws are commensurately developed, the lower jaw of the macrodontal races exceeds that of the

* These and the succeeding averages are from my own measurements, taken from never less than ten individual cases.

meso- or microdontal races in weight. Thus that of a male Australian exceeds that of the average Englishman in the proportion of 100:91.

To work this heavier jaw more powerful muscles are needed. In the average well-developed Englishman with perfect teeth the weight of the fleshy portion of the great jaw-muscles, masseters and temporals, is 60 grammes, while the weight of those as ascertained in two Australians was 74 grammes.

Correlated with this greater musculature a sharper definition of the areas for the attachments of the jaw-muscles is required. The muscular fascicles are approximately of uniform size in both microdonts and macrodonts, as the range of motion of the jaw differs little in different races; but when the skull is smaller on account of the smaller size of the brain which it contains, the temporal crest ascends higher on the side-wall. In the average Englishman the temporal crests at their points of greatest approximation anteriorly across the brows are 112 mm. apart, but in the Australian they are only separated by 103 mm.; the interstephanic distances in these two are respectively 132 and 114 mm.

The more powerful stroke of the mandibular teeth upon the anvil of the upper-jaw teeth in macrodonts renders necessary a proportionally stronger construction of the bases of support for the upper alveolar arch. In any skull this arch requires to be solidly connected to the wall of the brain-case to which the shock of the impact is ultimately transmitted, and in order to protect from pressure the delicate intervening organs of sight and smell, the connection is accomplished by the reversed arches of the infraorbital margins with their piers, malar and maxillary, founded on the frontal angular processes. These foundations are tied together by the strong supraorbital ridge, so that the whole orbital edge is a ring, made up of the hardest and toughest bone in the skeleton.

A twofold modification of this arrangement is required in the macrodont skull. The bony circumorbital ring becomes stronger, especially along its lateral piers, and also as the alveolar arch is longer, and consequently projects farther forward, its basis of support must be extended to meet and bear the malar and maxillary piers. But macrodonts are often microcephalic, and therefore the frontal region of the skull must be adjusted to form a foundation for this arch. In the average English male skull, held with its visual axes horizontal, a perpendicular dropped from the anterior surface of the fronto-nasal suture will cut the plane of the alveolar arch between the premolar teeth or through the first premolar. In an Australian skull the perpendicular cuts the horizontal plane at the anterior border of the first molar teeth.

It is obvious, therefore, that to insure firmness the piers of the

arches must be obliquely set, hence the jaw is prognathous; but it is also needful that the supraorbital arcade should be advanced to meet and bear these piers, as the mandibular stroke is always vertical.

But the inner layer of the skull is molded on the small frontal lobes of the brain, so this forward extension must affect only the much thicker and tougher outer table of the skull, which, at the period of the second dentition, here separates from the inner table, the interval becoming lined by an extension of the mucosa of the anterior ethmoidal cell. In this way an air-space, the frontal sinus, is formed, whose development is thus directly correlated to the two factors of brain development and size of the teeth. If the frontal lobes are narrow in a macrodont skull, then the foundations of the outer or malar piers of the orbital arch must be extended outward as well as forward, the external angular process becoming a prominent abutment at the end of a strong, low-browed supraorbital arch, whose overhanging edge gives to the orbital aperture a diminished vertical height.

The crania of the two most macrodont races of mankind, Australian and African, differ in the relation of the jaw to the frontal bone. In the microcephalic Australian the maxillæ are founded upon the under side of the shelf-like projection of the outer table of the frontal, which juts out as a buttress to bear it. On the other hand, the nasal processes of the mesocephalic negro ascend with greater obliquity to abut on the frontal, and have, by their convergence, crushed the nasal bones together and caused their coalescence and diminution.

The crania of the two most microcephalic races present distinctive features of contrast along the same lines. The Bushman's skull is usually orthognathous, with a straight forehead and a shallow fronto-nasal recess; while the Australian skull is prognathous, with heavy overhanging brows. These conditions are correlated to the mesodontism of the Bushman and the macrodontism of the Australian respectively.

In the course of the examination of the relations of brain development to skull growth some interesting collateral points are elicited. The frontal bone grows from lateral symmetrical centers, which medially coalesce, union taking place usually between the second and sixth years of age. It has been noticed by anthropologists that metopism, as the anomalous non-union of the halves of this bone has been termed, is rare among microcephalic races, occurring only in about one per cent among Australian skulls. Increased growth of the frontal lobes as the physical accompaniment of increased intellectual activity interposes an obstacle to the easy closure of this median suture, and so in such races as the ancient Egyptian, with a broader forehead, metopism becomes

commoner, rising to seven per cent. In modern civilized races the percentage ranges from five to ten. In following out the details of this enumeration I have spoken as if the microdontal condition had been the primary one, whereas all the available evidence leads to show that the contrary was the case. The characters of all the early crania, Neanderthal, Engis, and Cromagnon, are those of macrodonts. The progress has been from the macrodont to the microdont, as it probably was from the microcephalic to the macrocephalic.

The effects of the variations in size of the teeth are numerous and far-reaching. The fluctuation in the weight of the jaw depending on these variations has an important influence on the center of gravity of the head, and affects the set of the skull on the vertebral column. This leads to a consequent change in the axes of the occipital condyles, and it is one of the factors which determine the size of the neck-muscles, and therefore the degree of prominence of the nuchal crests and mastoid process.

As the teeth and alveolar arches constitute a part of the apparatus for articulate speech, so these varieties in dental development are not without considerable influence on the nature of the sound produced. The necessarily larger alveolar arch of the macrodont is hypseloid or elliptical, more especially when it has to be supported on a narrow frontal region, and this is associated with a more extensive and flatter palatine surface. This, in turn, alters the shape of the mouth cavity, and is associated with a wide flat tongue, whose shape participates in the change of form of the cavity of which it is the floor. The musculature of the tongue varies with its shape, and its motions, upon which articular speech depends, become correspondingly modified. For example, the production of the sharp sibilant S requires the approximation of the raised flexible edge of the tongue to the inner margins of the teeth behind the canines, and to the palatine margin close behind the roots of the canine and lateral incisor teeth. This closes the vocal tube laterally, and leaves a small lacuna about 5 mm. wide anteriorly, through which the vibrating current of air is forced. A narrow strip of the palate behind the medial halves of the median incisors bounds this lacuna above, and the slightly concave raised tongue-tip limits it below.

With the macrodont alveolar arch, and the correspondingly modified tongue, sibilation is a difficult feat to accomplish, and hence the sibilant sounds are practically unknown in all the Australian dialects.

It is worthy of note that the five sets of muscular fibers, whose function it is to close laterally the flask-like air-space between the tongue and the palate, are much less distinct and smaller in

the tongues of the Australians which I have examined than in the tongues of ordinary Europeans.

There is a wide field open to the anatomical anthropologist in this investigation of the physical basis of dialect. It is one which requires minute and careful work, but it will repay any student who can obtain the material, and who takes time and opportunity to follow it out. The anatomical side of phonology is yet an imperfectly known subject, if one may judge by the crudeness of the descriptions of the mechanism of the several sounds to be found even in the most recent text-books. As a preliminary step in this direction we are in urgent need of an appropriate nomenclature and an accurate description of the muscular fibers of the tongue. The importance of such a work can be estimated when we remember that there is not one of the 260 possible consonantal sounds known to the phonologist which is not capable of expression in terms of lingual, labial, and palatine musculature.

The acquisition of articulate speech became possible to man only when his alveolar arch and palatine area became shortened and widened, and when his tongue, by its accommodation to the modified mouth, became shorter and more horizontally flattened, and the higher refinements of pronunciation depend for their production upon more extensive modifications in the same directions.

I can only allude now very briefly to the effects of the third set of factors, the sizes of the sense organs, on the conformation of the skull. We have already noted that the shape and the size of the orbital opening depend on the jaw as much as on the eye. A careful set of measurements has convinced me that the relative or absolute capacity of the orbital cavity is of very little significance as a characteristic of race. The microseme Australian orbit and the megaseme Kanaka are practically of the same capacity, and the eyeballs of the two Australians that I have had the opportunity of examining are a little larger than those of the average of mesoseme Englishmen.

The nasal fossæ are more variable in size than the orbits, but the superficial area of their lining and their capacity are harder to measure, and bear no constant proportion to the size of their apertures, because it is impossible without destroying the skull to shut off the large air sinuses from the nasal fossæ proper for purposes of measurement. Thus the most leptorhine of races, the Eskimo, with an average nasal index of 437, has a nasal capacity of 55 c. c., equal to that of the platyrhine Australian, whose average is 54·5, and both exceed the capacity of the leptorhine English, which average about 50 c. c. There is an intimate and easily proved connection between dental size and the extent of the nasal floor and of the pyriform aperture.

These are but a few of the points which a scientific craniometry

should take into consideration. There are many others to which I can not now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race-characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presumption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated with diminution of use in the one case and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long- and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, nine per cent showed displacement or disease, and 1½ per cent show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in one per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvelous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilized peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

> "of every function shorn
> Except to act as basis for a corn."

In one per cent of adults the second and third joints have anchylosed, in three per cent the joint between them is rudimentary, with scarcely a trace of a cavity, in twenty per cent of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere

shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of Nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has insured that there shall be an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment, or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is

probably due to the imperfection which characterizes even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavor to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of anthropology, the science of education; and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And, lastly, we shall make progress in that kindred department, sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an anthropological Utopia?—*Reprinted from Nature.*

SOME VEGETABLE MALFORMATIONS.

By Prof. BYRON D. HALSTED.

BY malformations are here understood those structures that are so unusual as to attract attention and so curious as to suggest that they are individual freaks to be explained by some peculiarity of surroundings or not at all. They may occur more frequently with some species of plants than with others, but are usually outside of the reign of the rules of inheritance, and therefore not governed by the ordinary laws of vegetative growth.

It is the purpose here first to treat of some of the more common and striking of these monstrosities, and then, if possible, to indicate how these extravagant forms may serve as keys to unlock some otherwise hidden secrets in vegetable morphology.

It is difficult to make any satisfactory classification of these monstrosities, and therefore instances will be given somewhat in the following order—namely, those of stems, of leaves, of flowers, and finally of fruits. One of the most frequent abnormities of the stem is that where, instead of the nearly cylindrical form, it becomes broad and ribbon-shaped. This type of malformation is confined to the less woody stems, as those of the asparagus. Fig. 1 shows such an instance, where the stem broadened out to nearly

four inches in some places, while its thickness is less than half an inch. Numerous small side branches arise from the broad surface of this peculiar shoot, while the end is made up of a large number of small buds fused together. As they grow, the individual stems lose their identity in the common belt of blended shoots. The photograph is made from a specimen brought last spring to the writer's laboratory, where the upper foot or more is still to be seen preserved in a large museum jar.

FIG. 1.—ASPARAGUS FASCIATION.

The sweet-potato vine perhaps most frequently illustrates this broadening of the stem, but upon a less grand scale than that shown in the asparagus. Only last week a student brought me a plant in which all the several vines were like ribbons, an inch or more in width and several feet in length. It is only a singular instance of a failure of the young formative branches to separate as they are developed from the closely situated buds at the tip; but that this failure should be constant in all the branches of a plant is more difficult to explain.

The reader will call to mind several other kinds of plants that illustrate this same abnormity, to which botanists have given the name of *fasciation*, from the resemblance of the stem to a bandage. Larkspur and dahlia stems sometimes show the same peculiarity, and, should we here include flower-stalks, the dandelion would afford abundant examples, for the long, hollow scapes are frequently doubled or flattened to a ribbon that sometimes has not strength enough to support the abnormal head of flowers. The garden "cockscomb" (*Celosia*) owes its attractiveness largely

to the unusual development of the stem at its upper end, together with the high color and the fantastic shapes assumed. This is one of the few exceptions to the rule that a fasciation of the stem is not constant.

Last summer, while looking through the nursery rows of a propagator of hardy perennials, my attention was attracted to the stems of the large-flowered bell-flower (*Campanula grandiflora*). Instead of the cylindrical stem and the loose spray of flowers, these two had developed as shown in the asparagus, and from the broad, flat stalk the flowers were closely arranged. At the enlarged end there were several buds and blossoms more or less blended. In one instance three separate flowers were so closely grown together as to appear as a single monstrous blossom.

Passing now to leaves, the reader will perhaps first of all think of the so-called "four-leaved" clover, in which, instead of the ordinary three leaflets, there is an additional one, or possibly two or more, the abnormity sometimes running as high as seven leaflets. Some years ago, while in Iowa, the writer found a clover plant with fourteen leaves having four leaflets and seventeen with five leaflets, and these outnumbered the ordinary ones. A "six-leaved" leaf found upon another plant had a lobe growing from one side of one leaflet resembling a mouse's ear. There are clover leaves in which the fourth leaflet is shaped like a funnel. The same shape is rarely seen in geranium leaves, and cabbage and lettuce leaves sometimes show strange outgrowths from the middle of the under side. Twin leaves at the most unexpected places are, to say the least, surprising. One such in my possession is of the lilac, which ordinarily has foliage of a well-defined form.

FIG. 2.—PROLIFEROUS ROSES.

It is when we come to the flower that the greatest absurdities are to be found. Plants may have their stem fasciated and their leaves with strange lobes and incisions, but in the blossom they sometimes go quite "crazy." Gardeners occasionally send or

even bring roses that have taken on such peculiar developments that one can scarcely refrain from a smile when the structure is examined. Fig. 2 shows a sample that came to me accompanied by some most difficult questions. Instead of the blossom terminating the branch, as is usually the case, there is a continuation of the cane beyond the flower, where it forms leaves and new buds. This *prolification*, as it is termed, is found at rare intervals and in a less conspicuous manner in perhaps

FIG. 3.

FIG. 4.

FIG. 5.

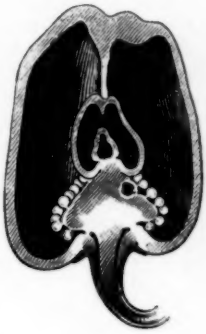


FIG. 6.—ABNORMAL PEPPERS.

FIG. 7.—PEAR WITH BRANCH.

a hundred different genera of plants. The plantains show this prolific manner of producing flowers in a marked degree, as also do the garden pinks.

In the doubling of flowers—that is, the change of stamens or pistils or both into petals—there are many strange combinations produced. All gradations between the perfect stamen with its pollen-bearing tip and the normal petal can be found. In such large flowers as the pæonia the malformations seem like a fruitless struggle between two contending forces, one to keep the flower single and sexual and the other to reduce all parts to a barren neutrality. In the lilies a similar confusion arises in the attempt of the blossoms to hold their essential organs while the surrounding conditions are such as to turn them into the more showy petals. All this multitude of instances, while of exceed-

ing interest to the student of floral structures, is perhaps more monotonous than amusing from the point of view of this paper, which deals more particularly with the unexplainable and eccentric than with strange shapes that are the natural result of an underlying law. Thus the garden petunia "doubles" easily, and in so doing loses its stamens, or some of them, and much of its former beauty. In a study of this process some three years ago, in which hundreds of specimens were examined, a peculiarity of still greater interest than the simple changing of stamens into petals was brought to light. The unusual size of the petals in some of the doubled flowers led to a dissection of them, when it was found that the contents consisted of stamens partly changed into petals and often highly colored, while in the center of all was a small pistil about one third the normal size. Not infrequently the ovarian stamens had their anthers tipped with a small stigmatic surface, thus indicating the close association of the sexual elements in the floral structures. Fig. 3 shows a normal pistil, the one at Fig. 4 is from a doubled blossom, and Fig. 5 shows the secondary pistil at the center.

FIG. 8.

Last year, while examining some peppers for a fungous disease, a peculiar formation was met with that comes in the same category with the petunia above mentioned. In making a longitudinal section of the fruit, the seed-bearing column was found crowned by a small pepper which in itself was a fruit in miniature. This freak is shown in Fig. 6.

It is an easy step from flower to fruit, for the latter is a part of and a natural result of the former. The prolification seen in the rose and in many other flowers has its counterpart in fruits of various kinds. Thus, strawberries have been known to bear a branch at the free end, and pears sometimes exhibit the same freak. Fig. 7 shows such a fruit with a branch and a number of leaves extending beyond the blossom end.

Instead of a leaf-bearing shoot, the axis is extended by the production of another fruit, or branching may take place in an irregular way, and a structure as monstrous as that shown in Fig. 8 results.

The apple as well as other fruit is not infrequently twinned by the union of two forming buds, as shown in Fig. 9. In others there is less frequently a second row of seed cavities, thus making a "two-storied" fruit, so to speak, as seen in Fig. 10.

Passing below ground, there are more abnormities to be found than most persons are aware of. The peculiar conditions that attend the subterranean habit favor monstrous growths. Not long ago a cluster of sweet potatoes was brought to me. Some were all red upon the surface, others were all yellow, and some were one half red and the other side yellow. The Irish potato is fertile in its freaks. Seemingly not content with the underground situation, potatoes sometimes appear upon the branches among the leaves. Occasionally a potato when planted whole will develop other new and small potatoes beneath the skin and

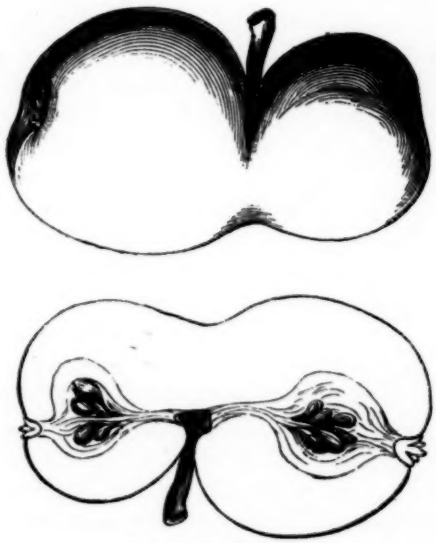


FIG. 9.—TWIN APPLE.

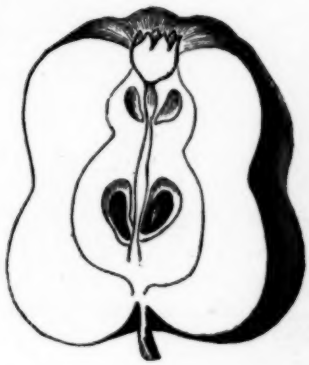


FIG. 10.—TWO-STORIED APPLE.

out of sight, which only calls to mind how a hollow turnip may have its cavity filled with an after-growth of foliage, only to be discovered when the root is cut in two.

Sometimes the abnormal growths bear a strong resemblance to some other object very far from the one really shown. Thus Fig. 11 shows what might well pass for the human hand, but it is nothing more or less than an ear of corn with the grain removed. Instead of ending in the usual way, it has become

branched, thus giving rise to the "fingers," while the lower portion of the cob makes a fair-shaped "wrist." The engraving is made from a photograph recently sent from Missouri.

It would be impossible to mention the instances even of abnormal forms in seeds, or to go further and show how there may be monstrous forms that can only be seen through the compound microscope.

FIG. 11.—HAND-COB.

The molds, mildews, rusts, smuts, and various blights that feed upon higher plants have their freaks that are sometimes puzzling to those who study these minute structures.

A large museum might be filled with the eccentricities of the vegetable world. Some of them would only teach the lesson of a lack of equilibrium among the laws which determine definite lines of growth. Others would serve to open the door to some hidden fact of vegetable morphology. Thus, the interchange of stamens and pistils in some abnormal blossom teaches the lesson of the common origin of the two essential organs, while the gradation of either or both to floral envelopes indicates that pistils are only petals of a special form for a special purpose. In short, the malformations as we speak of them are only forms in less than their usual disguise. The leaf is the unit of structure in the flower, and the flower is a metamorphosed branch, which may terminate in a seed-vessel, as the pear, or in rare instances in a leafy branch beyond the fruit, thereby corroborating the belief that the fruit is a part of a stem.

Some one has said that when under the influence of an intoxicant the victim throws off his disguise and lets his inner self

appear; so likewise the plant, when it for some reason not easily seen departs from the normal, lets the thoughtful student of plant nature get glimpses of truth not otherwise vouchsafed to him. Teratology is not chaos, neither are malformations meaningless. The unit of origin of parts is no better demonstrated than through some of the "inebriated" conditions as found from time to time in the kingdom of plants.

MARRIAGE AND KINSHIP AMONG THE ANCIENT ISRAELITES.

By Colonel A. B. ELLIS.

IN the article on Polyandry which appeared in The Popular Science Monthly for October, 1891, we had occasion to refer to the custom of raising up seed to a deceased elder brother as indicating that the Israelites had formerly practiced that form of polyandry in which the associated husbands are brothers; and in the present article we propose to pursue the investigation there hinted at, and to inquire to what extent the Israelites conformed to what appear to have been the normal phases of evolution of marriage and kinship in early times. To clear the ground, it will be convenient to commence by briefly stating what those phases were:

1. There was a primitive condition of which we can ascertain with certainty little or nothing; but, from the analogy of the lower animals, we infer that unions were not for life, and that couples paired for as long as it suited them, or until the child was weaned.

2. This condition was upset by the practice of female infanticide, which caused men to become much more numerous than women.

3. The inevitable result of this disproportion was either that the men of a community held their women in common, or that several men attached themselves to each woman, forming unions of the type of the ruder polyandry.

4. At the same time men strove to add to the number of their women by seizing and carrying off the women of other communities. Marriage by capture commenced.

5. As a result of a community in women, or of polyandry, and also as a result of marriage by capture, the paternity of children would always be uncertain. Hence, fathers being unknown, there could be no kinship in the male line. Kinship and descent would be traced solely through mothers, as we find is the case among nearly all the lower races at the present day.

We need go no further than this, though many other changes ensue; and we will now see what traces may be found in the books of the Old Testament, to indicate that the Israelites passed through these several phases.

First, as to marriage by capture. We read in Genesis, xxxi, 26, that when Jacob had secretly made off with his wives and flocks, Laban upon overtaking him asked, "What hast thou done, that thou hast stolen away unawares to me, and carried away my daughters as captives taken with the sword?" From which it is evident that the practice of carrying off women by force was not unknown. In Numbers, xxxi, we read that the Israelites, having defeated Midian, saved thirty-two thousand virgins as booty. They had at first spared all the women, as spoil, which shows that it was quite usual to do so; but on this occasion Moses induced them to murder all those who were not virgins. In Deuteronomy, xx, 14, women are classed as spoil; and in Deuteronomy, xxi, 11, 14, are the regulations to be observed in taking to wife a woman captured in war. In the song of praise attributed to Deborah and Barak, when exulting over the defeat and death of Sisera, we find (Judges, v, 30): "Have they not sped? have they not divided the prey: to every man a damsel or two?" These are all cases of capture *de facto*, and they show conclusively that the Israelites captured women and took them to wife. That it was also a common practice among the neighboring nations we infer from I Samuel, xxx, 5, where David's two wives are carried off by a raiding party of Amalekites.

But, besides hostile captives, the Israelites had also marriage with the form of capture—an important point, for it shows that marriage by capture had formerly been the normal mode of obtaining a wife, and that the custom of ages had caused a semblance of violence to be considered necessary, even in marriages made by arrangement. The Old Testament phrase is to "take" a wife, as for example Genesis, xxiv, 67: "And Isaac brought her into his mother Sarah's tent, and took Rebekah, and she became his wife"; Genesis, xxxviii, 2: "And Judah saw there a daughter of a certain Canaanite, whose name was Shuah; and he took her"; Numbers, xii, 1: "For he (Moses) had taken an Ethiopian woman"; Judges, xiv, 7, 8: "And he went down and talked with the woman, and she pleased Samson well, and after a time he returned to take her"; Tobit, vii, 12, 13: "Then take her from henceforth according to the manner"; and "Behold, take her after the law of Moses." This "taking" was a form of capture. Dr. Smith, in his Dictionary of the Bible, article "Marriage," remarks that "taking a wife" seems to be literally meant, and that the "taking" was the chief ceremony in the constitution of a marriage. In the case of Samson we read: "They brought thirty

companions to be with him"—that is to say, they brought thirty men to represent the party of the bridegroom in the form of capture, the bringing being necessary in Samson's case because he had none of his own people with him. One of these thirty acted as leader, or best man, and Samson's wife was afterward given to him (verse 20)—a proceeding quite in accordance with existing practices among some people who marry with the form of capture.

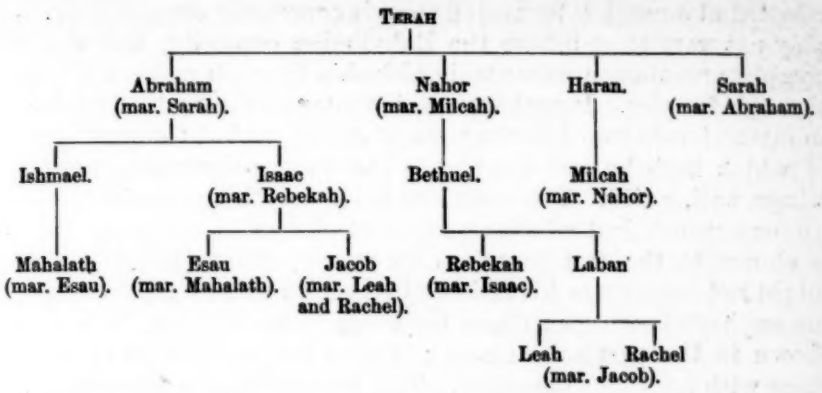
We find a clear case of marriage with the form of capture in connection with the civil war with the tribe of Benjamin. The remnant of Benjamin, six hundred in number, who survived the war, were all men. There were no women left, and as the other tribes had sworn that they would not give their daughters in marriage to the men of Benjamin, there was a prospect of that tribe becoming extinct. In this dilemma the tribes attacked Jabesh-gilead and captured four hundred women, who were handed over to Benjamin; but, as this left two hundred men still unprovided for, they contrived the following plan: A yearly festival was held at Shiloh, at which it was customary for the girls to come out and dance. So they instructed the men of Benjamin to lie hid in the vineyards, and when the girls appeared each man was to seize one and carry her off. So it was done, and in this way the tribes kept the letter of their oath and evaded the spirit. They did not give their daughters to Benjamin, but they connived at their being carried off with the form of capture (Judges, xxi).

The Israelites thus had both marriage by capture *de facto* and marriage with the form of capture, and in the former article we showed that they had once been polyandrous. Now we know that marriage by capture is in its origin due to a scarcity of women, though it is persevered in through custom after that scarcity has ceased to exist. Likewise, polyandry, the marriage of one woman to two or more men, only exists where women are less numerous than men. Consequently, since the Israelites had both these practices, there must have been a period in their history when women were fewer in number than men, and experience and observation all over the world have shown that such a disparity can only be brought about by female infanticide. We conclude, therefore, that the Israelites passed through our second, third, and fourth phases, and will now proceed to see if they also passed through the fifth.

From the fact of their having been polyandrous and having married by capture, we should infer that they must, at the period when these were the normal types of marriage, have had a system of kinship through females. If there were two or more husbands to one wife, the father of a given child could not be determined;

and if women were carried off by force from neighboring tribes and then married, there could be no certainty that the child borne by a captive woman was the offspring of one of the men in whose keeping she happened to be at the time of its birth. Fathers being thus uncertain, if not absolutely unknown, the paternal tie could not be taken into account. Blood-relationship would be traced through the mother, and this system would, through custom, prevail long after the conditions which gave rise to it had come to an end. Independently, then, of any evidence that may be forthcoming, we should conclude that the Israelites must at one time have had a system of kinship through mothers.

We now come to another point. There is no known case of a nation having marriage by capture and marriage with the form of capture without being exogamous; and since the Israelites had both these customs we infer that, unless they were altogether exceptional, they were also exogamous—that is, they prohibited marriage between those who were recognized as being related by blood. When we examine in detail all the marriages mentioned in which it is possible to trace the pedigrees both of husband and wife, we find that there is not one that would violate the principle of exogamy if descent were in the female line, while there are a great number which could not possibly occur if the Israelites were exogamous and traced descent in the male line. For instance, Nahor, Abraham's brother, married the daughter of his brother Haran (Genesis, xi, 29)—his niece, if descent were in the male line, but no relation if in the female. Abraham married his father's daughter (Genesis, xx, 12)—his half-sister if kinship was traced through males, but if through females, no relation. Marriages of this kind, it may be mentioned, are peculiar to the system of female descents and could not occur under any other system of kinship, if marriages between blood-relations were forbidden. We see in this case, too, what a point Abraham made of explaining that his wife was not the daughter of his mother, but only of his father. Isaac married Rebekah, granddaughter of his paternal uncle Nahor, who had himself married his brother's daughter (Genesis, xxiv, 15). Isaac and Rebekah would not be blood-relations if descent were in the female line. Esau married the daughter of Ishmael, his uncle on the father's side (Genesis, xxviii, 9; xxxvi, 3). Jacob married the daughters of his maternal uncle, Laban (Genesis, xxix, 10, 16). With descent in the female line Laban would be Jacob's blood-relation, but his daughters would not, since they would be of the kin of their mother. Laban and Jacob were both great-grandsons of Terah, and the following "tree" will show to what an extent, if kinship was reckoned in the male line, the descendants of Terah knowingly intermarried in the same blood.



That the Israelites married relations on the father's side is thus indisputable, but if they were exogamous, as we must believe them to have been, since they had marriage by capture and marriage with the form of capture, marriages between blood-relations were forbidden; hence we must conclude that relations on the father's side were not accounted blood-relations, and that kinship and descent were traced through mothers exclusively.

All the above cases, and that of Amram, father of Moses, who married his father's sister (Exodus, vi, 20), are anterior to the Levitical law, which forbade marriage with a sister-german, or by the same father, and also with a father's sister; and so, had it been then in force, would have prevented the marriage of Abraham with Sarah, and that of Amram with Jochebed. The Levitical law was therefore an innovation, since it prohibited marriages which had formerly been allowed. It also prohibited marriage with a brother's wife, which is generally taken as meant to include his widow; but as in Deuteronomy, xxv, 5, a man is enjoined to marry his brother's widow, if the brother had died childless, it seems probable that the prohibition in Leviticus, xviii, 16, was directed against that form of polyandry in which the associated husbands are brothers, which, as we have before shown, the Israelites certainly at one time had.

As we have said, the Levitical law changed the existing custom; yet, strangely enough, long after the supposed date of its promulgation, we find Tamar, in the affair with her half-brother Amnon, saying (I Samuel, xiii, 13): "Speak to the king, for he will not withhold me from thee," just as if marriage with a sister-german was quite customary and had not been forbidden. From this we are driven to conclude that the Levitical law is misplaced chronologically—a conclusion which M. Renan seems also to have arrived at.* It seems probable that the Levitical code was really

* History of the People of Israel, vol. i, p. 166; vol. ii, pp. 169, 298.

adopted at a much later period than is commonly supposed, probably not very long before the Babylonian captivity, and was a complete revolution, substituting kinship through males for that through females. It perhaps was included in the book of the law so mysteriously found in the reign of Josiah, and of the provisions of which both he and the people had been entirely ignorant (II Kings, xxii, xxiii). The marriage law seems to have been drawn up for a people just adopting a system of female descents. This is shown by the fact that the only aunt by marriage that a man might not marry was his father's brother's wife; he might marry his mother's brother's wife, or his wife's father's sister. It is also shown in the particular stress laid upon the prohibition of marriage with a father's daughter. This is forbidden in verse 9, and again, with more detail, in verse 11. Such a marriage would be perfectly lawful under a system of female descents, and that of Amnon with Tamar would have been one of this class. From Ezekiel, xxii, 11, it would appear that such marriages continued to be common among the Israelites up to the time of the overthrow of Jerusalem. If the Levitical law is not misplaced, how comes it that, in spite of the particular manner in which such marriages are forbidden, David would not have withheld Tamar from Amnon?

There are, besides, other reasons for supposing that if the books of the Old Testament were arranged in order of publication, Leviticus ought to be placed toward the end of Kings. By the Levitical law only priests and Levites were to offer sacrifices and "inquire of the Lord," yet Samuel, who was neither, did both, as did Saul, and David, and many others, among them Joshua, a Beth-shemite (see I Samuel, vi, 14, 15; xiii, 9; xiv, 37; xxiii, 2, 4; II Samuel, ii, 1; v, 19, 23; vi, 18). The Levitical law also condemned those who sacrificed in "high places," or away from the sanctuary, where the ark was present; yet Samuel (I Samuel, ix, 13) went up to a "high place" to sanctify the sacrifice, and afterward disposed of that portion which, according to Leviticus, vii, 31–34, belonged to the priest; and David is made to say (I Chronicles, xiii, 13), "Let us bring again the ark of our God to us, for we inquired not at it in the days of Saul." All these acts and omissions were violations of stringent laws, yet no one seems to have been aware that they were doing wrong, and the only inference to be drawn is that the laws did not then exist. This gains further support from the fact that we read in I Kings, viii, 9, that when Solomon brought the ark to the temple there was nothing in it but the two tables of stone, though the ark was the place in which the book of the law was to be kept (Deuteronomy, xxxi, 26), and that we hear nothing of any book of the law till Hilkiah, the high priest, alleged that he found one during the reign of Josiah.

Moreover, when we look into the marriages mentioned in Joshua, Judges, Samuel, and Kings, we find that they exhibit the same peculiarity as do those mentioned in Genesis. They could all take place if the Israelites were exogamous, and had descent in the female line, while many could not possibly take place if they were exogamous, and had descent in the male line. It is needless to multiply examples, and the two following will be sufficient. (Joshua, xv, 17:) Othniel, son of Kenaz, the brother of Caleb, married Caleb's daughter. (II Chronicles, xi, 18:) Rehoboam, son of Solomon, (1) Mahalath, his first cousin on the father's side; (2) Abihail, his father's first cousin; and (3) Maachah, his first cousin on the father's side. There may be some doubt about the last wife. In II Chronicles, xi, 20, and I Kings, xv, 2, she is called the daughter of Absalom; but in II Chronicles, xiii, 2, she is called the daughter of Uriel of Gibeah.

It may be objected that the Israelites could not have been exogamous because they were endogamous; but the fact is that they were not endogamous till after the Babylonian captivity, and were not endogamous in the true sense even then. Endogamy is that law which allows marriage only between persons who are recognized as being of the same blood; and though, after the captivity, the Israelites made a law against marrying foreigners (Ezra, x; Nehemiah, x, xiii; I Esdras, ix), yet at the same time they observed the Levitical law forbidding marriage within certain degrees of consanguinity. They had thus an endogamy of nationality, coupled with exogamy within the nation.

But even this external endogamy, so to speak, did not exist before the captivity, for the evidence that the Israelites did marry foreigners is overwhelming. There was marriage with foreign women taken in war, and rules governing the procedure in such cases. Then of individual examples we have the following: Abraham took Hagar, an Egyptian, and Keturah, an Arab (Genesis, xvi, 3, and xxx, 1). Esau married a Hittite and a Hivite (Genesis, xxxvi, 2). Judah married Shuah, a Canaanitish woman (Genesis, xxxviii, 2). Joseph married Asenath, an Egyptian (Genesis, xli, 45); and Moses, Zipporah, an Ethiopian (Exodus, ii, 21, and Numbers, xii, 1). Simeon married a Canaanitish woman (Exodus, vi, 15).

The first limitation of marriage with foreigners is found in Deuteronomy, vii, 1–3, where the Israelites are forbidden to intermarry with seven nations—the Hittites, Girgashites, Amorites, Canaanites, Perizzites, Hivites, and Jebusites. But the Israelites did not obey this prohibition * (Judges, iii, 6, and I Kings, xi, 2), and

* We suppose here, for the sake of argument, that the prohibition existed at this time, though there are good reasons for believing that Deuteronomy was really written by Jeremiah.

marriages with the women of other nations naturally continued. Thus, Boaz married Ruth, a Moabitess; David, the daughter of the King of Geshur (II Samuel, iii, 4), and Solomon married a number of foreign women (I Kings, xi, 1). We equally find cases of Israelite women having married foreign men. In Leviticus, xxiv, 10, we read of a woman of Israel who had a son by an Egyptian. Abigail, David's sister, married an Ishmaelite (I Chronicles, ii, 17); and the daughter of Sheshan married an Egyptian (I Chronicles, ii, 34, 35). In Judges, xii, 8, 9, we read that Ibzan had thirty sons and thirty daughters. He sent the latter abroad, and took in thirty women from abroad for his sons. All these examples show conclusively that the Israelites married foreigners, and that therefore they were not endogamous.

When a nation adopts an endogamy of nationality, it may invariably be ascribed to one of two causes: either the nation is, or considers itself to be, superior to its neighbors, and, having become dominant in war, refuses to intermarry with those it considers inferior; or the surrounding nations consider themselves superior, and refuse to intermarry with a people whom they regard as inferior. In the one case the endogamy is voluntary, in the other it is involuntary. Now the first could not have been the case with the Israelites; they were not dominant in war, and if they considered themselves superior to their neighbors, they did not carry their exclusiveness so far as to decline to marry their women. But during the captivity it is exceedingly probable that, as a conquered people, they were despised by their conquerors, and compelled, to a great extent, to marry among themselves. In Tobit, iv, 12, 13, we find a father saying to his son, "Despise not in thy heart thy brethren, the sons and daughters of thy people, in not taking a wife of them"—a speech which seems to acknowledge that the Israelites were despised. The number of those who married foreign women, as given in Ezra, x, is exceedingly small out of a body of 42,360 males (Ezra, i, 2, 64); and it is most probable that a national endogamy was forced upon the Israelites during the captivity. Then, it seems that the priests took advantage of the opportunity, and endeavored to make it a national characteristic, alleging for this purpose that it was an old law, and that all the misfortunes of the nation were to be attributed to its violation in times past.

From this necessary digression we return now to the consideration of the evidence of female descents. Another indication of that system is the strong affection between brothers and sisters uterine, as compared with that between brothers and sisters german; for, if descent were in the male line, the blood-tie derived from the common father ought to have had the greater weight.

It is Simeon and Levi, uterine brothers of Dinah, who revenge the affront offered her, and when reproved by Jacob they say, "Should he deal with our sister as with a harlot?" The other sons of Jacob took no part in the act of treachery (Genesis, xxix, 33, 34; xxx, 21; xxxiv, 25, 31). Notice, too, the love which Joseph has for Benjamin, "his mother's son" (Genesis, xliii, 29, 30), and how cold by comparison is his regard for his brothers-german. The rape of Tamar is revenged by her uterine brother Absalom, who causes Amnon to be murdered (II Samuel, xiii, 28). It is interesting to note the language used in this case (II Samuel, xiii, 1): "And it came to pass after this that Absalom, the son of David, had a fair sister, whose name was Tamar; and Amnon, the son of David, loved her"; and (verse 4), "And Amnon said unto him, I love Tamar, my brother Absalom's sister." The relationship between Tamar and Absalom is evidently regarded as something very different from that between her and Amnon. Indeed, in our view, Tamar and Amnon were not regarded as related at all. In verses 2, 5, 6, etc., Tamar is spoken of as Amnon's sister; but then it must be remembered that the term sister was used in a very comprehensive sense, and included female cousin, and in fact women generally of about the same age as the speaker. In Tobit, v, 20; vii, 16; and xviii, 14, are examples of a husband addressing his wife as sister.

Another indication is found in the numerous cases in which men are described as the sons of their mothers, as if the maternal descent were of more moment than the paternal. Bethuel is described as "son of Melcah, the wife of Nahor, Abraham's brother" (Genesis, xxiv, 15). Joab is generally styled "the son of Zeruiah" —that is, after his mother (II Samuel, xxiii, 18; I Kings, i, 7; I Chronicles, xxvi, 28). Abishai, Joab's brother, is also called the son of Zeruiah (II Samuel, xiv, 21; xviii, 2). David calls them both "ye sons of Zeruiah" (II Samuel, xix, 22).

Much more important, however, than these, are the cases in which the son is clearly regarded as being of the kin and nation of the mother rather than of the father. Abimelech was son of Gideon by a Shechemite woman, and, if descent were in the male line, he could not have been considered a Shechemite; but the story, as narrated in Judges, ix, shows clearly that he was considered one. His mother's brethren say, "He is our brother," and support his cause. Amasa was the son of Abigail, David's sister, by Jether the Ishmaelite (I Chronicles, ii, 17). If descent were in the male line, Amasa would have been reckoned an Ishmaelite, and not one of the Beni-Israel at all. But what are the facts? David sends to him, saying, "Art thou not of my bone, and my flesh?" and makes him captain over the host of Judah, his mother's tribe. Again, Sheshan gave his daughter in marriage to his

servant Jarha, an Egyptian, and the offspring of this union were regarded as Israelites (I Chronicles, ii, 34, 35)—that is to say, they traced descent and nationality through the mother. Here, then, we have three cases, one in which the male parent is an Israelite, and two in which the female parent is. In the former case the son is not considered an Israelite, and in the two latter he is—that is, in each case he is regarded as belonging to the nation of his mother. In this connection it is curious to note that in the list of the kings of Edom given in Genesis, xxxvi, 31–39, no king is the son of his predecessor; and in verse 39 we have a clear case of descent being traced through females: "His wife's name was Mehetabel, the daughter of Matred, the daughter of Mezahab."

All these examples are found prior to the Babylonian captivity, after which the custom was changed. In Ezra, ii, 61, and Nehemiah, vii, 63, we read that the children of a daughter of Barzillai, the Gileadite, were called after her family name, and were reckoned as not of Israel, because "they could not show their father's house, and their seed, whether they were of Israel" (Ezra, ii, 59).* Before the captivity Amasa, the son of an Israelitish woman by an Ishmaelite, and Attai, the son of an Israelitish woman by an Egyptian (I Chronicles, ii, 35), were reckoned as of Israel, the maternal descent was sufficient; but after the captivity it was considered necessary to show "the father's house." This seems to indicate that the change from a system of descents through females to one through males, which had no doubt been gradually taking place for some generations, was fully accomplished by the time that the two tribes returned from Babylon.

A point not to be overlooked is the inferior position held by women in post-captivity times. When kinship is traced through females, the position of women is necessarily high, for they are the heads of families; but when they lose the latter position through a change in the system of descents, they are commonly reduced to a condition more or less servile. Now we have some cases of women holding high positions before the captivity, notably Miriam, Deborah, and Huldah. The first is mentioned in Micah, vi, 4, as the equal of Moses and Aaron: "For I brought thee out of the land of Egypt, . . . and I sent before thee Moses, Aaron, and Miriam." In Exodus, xv, 20, she is styled a prophetess, and in Numbers, xii, 2, she and Aaron rebel against the leadership of Moses. She was evidently a person of authority, and so was Deborah the prophetess, for she judged Israel (Judges, iv, 4).

* In I Esdras, v, 38, this family is called "the sons of Addus, who married Augia, one of the daughters of Berzelus, and was named after his name."

Huldah, a prophetess, is mentioned in II Kings, xxii, 14, and II Chronicles, xxxiv, 12, as being consulted by the high priest and others. After the captivity we do not find women holding any such positions.

We may now claim to have shown that the Israelites passed through our fifth phase, and had a system of descent through mothers before they had one through fathers. We have shown that they had marriage by capture, and marriage in the form of capture, from which we must believe them to have been exogamous. They were certainly not endogamous, for they married foreigners. If they were exogamous, they could not have married in the recoghized blood-stock, and we can not find that they married into the maternal blood, though there is abundant evidence that they married into the paternal blood. We find a much stronger tie between brothers and sisters uterine than between brothers and sisters german; some cases in which men are styled the sons of their mothers, and others in which kinship and nationality are distinctly traced through the mother exclusively. It is only after the captivity that it is necessary to show the paternal descent. The system of kinship through females being the simplest, is naturally the first that is established; for kinship depends upon a perception of the unity of blood, and the most obvious and unmistakable case is that between mother and child. Once established, it lingers on, through custom, even after the tie between father and child has been recognized; and in the case of the Israelites it appears to have lasted till about the days of David, at which time they appear to have been in a state of transition,* as the Polynesians are now; and, finally, after contact with the Babylonians and Greeks, they effected a change to descent in the male line.

The Hebrew books are stated to have been restored by Esdras, when they had been destroyed by the Chaldeans (II Esdras, xiv, 21, 47), and, according to Eusebius, it is solely to his recollection that we are indebted for the books of the Old Testament. Now, at that time it was necessary for a man who claimed to be of Israel to show his father's house; Esdras was one of those who made this a *sine qua non*. The change to this system had, as we

* The normal course seems to be that the female system of descents is changed for one under which relationships are traced on both sides of the house, and this in turn is replaced by one through males. In the reign of David, relationship was certainly traced on both sides, for we read in II Samuel, xxi, that when it was considered necessary to sacrifice a number of members of Saul's family in order to stay a famine, the persons selected were two sons of Saul and five grandsons. The latter were the sons of Merab, daughter of Saul, by her husband Adriel the Meholathite. The sacrifice of the sons of Saul shows that descent was traced from father to son, and that of Merab's children, that it was also traced from mother to son.

have said, been probably gradually taking place for some generations, and what is certain is that the system of female descents had been left so far behind, that the compiler or compilers of the books had not the least suspicion that it had ever existed. That they had no knowledge of it is shown by the trouble they took to connect themselves in the male line with the traditional patriarchs by long lists of names of men. They filled up the gaps between persons mentioned in the traditions by lists of names of fathers and sons, as in Genesis, xi, between Shem and Terah; and that the indications of female descents we have noted were preserved, was doubtless due to the superstitious regard they had for the actual words of the oral traditions, and to the fact that the compilers had not the slightest conception of the inferences to be drawn from them. It is inconceivable that, after having invented pedigrees to connect themselves in the male line with the traditional patriarchs, they should knowingly have left evidence that affords a *prima facie* proof that descent was formerly in the female line, and the pedigrees consequently fictitious.

These pedigrees were no doubt introduced in support of the endogamy of nationality, which the priests enforced after the captivity. They were designed to prove that the Israelites were a chosen people, descended from Abraham, Isaac, and Jacob, and so all of one blood; but they were drawn up with so little care, that it is easy to prove from the books themselves that they are inventions of a later date. For example, we read in Exodus, vi, 3, that the national god, Jahveh, or Jah, only revealed his name shortly before the exodus, and expressly stated that his name was not known to the patriarchs; yet in Genesis, xlvi, among a number of names compounded of the names of "heathen" gods, we find some compounded of Jah. Reuben (verse 9) has a son named Carmi (Jah makes fruitful). Gad (verse 16), himself named after the Phœnician goddess of good fortune, has a son Areli (Jah is powerful). Asher (verse 17), named after the Assyrian god, has a son Beriah (Jah is vigorous, or Jah is my maker). Now, either these names must have been put into the text subsequent to the revelation of the name to Moses, or else the story of that revelation is apocryphal.

In regard to these pedigrees, the ancient Greeks furnish an exactly parallel example. They, like the Israelites, had arrived at a system of kinship through males, and had connected themselves by long lists of names of fathers with the traditional heroes and gods. They had so completely forgotten that they had ever had any other system of descents, that Herodotus, speaking of the Lycians, said that they differed from every other nation in the world in tracing descent through mothers. Yet the traditions of the Greeks, like those of the Israelites, contained

indications of the earlier system, which those who reduced the traditions to writing suffered to remain in ignorance of their real meaning; and, as Mr. McLennan, who collected those indications, has shown,* there can be no reasonable doubt but that the Greeks had a system of descents through mothers before they had one through fathers.

THE EARLY EXTIRPATION OF TUMORS.†

(*ABSTRACT.*)

By JOHN W. S. GOULEY, M. D.,
SURGEON TO BELLEVUE HOSPITAL.

IN a paper, bearing the title of A Plea for the Early Extirpation of Tumors, Dr. Gouley makes a succinct argument, based upon long experience, in favor of removing morbid growths from the human economy in a very early stage of their development. What follows is therefrom abstracted, with the object of presenting to the general reader the main points discussed, and of calling his attention to the importance of the subject, in consideration of the fact that more than two thousand persons die annually from the effects of cancerous tumors in the State of New York, and in about the same proportion in other States and countries. How this percentage of mortality may be lessened is suggested in the course of the discussion.

The paper begins with the question, At what period of the development of a tumor is its extirpation justifiable? The answers to this question, for a long time, have been divided between early and late surgical intervention and non-intervention. Some surgeons, at home and abroad, have favored and do now favor early extirpation even in the case of benign tumors, but many advise non-interference so long as tumors are small, painless, stationary, or of slow growth.

If it were generally known among intelligent people that great numbers of innocent tumors sooner or later become malignant, and that malignant tumors often simulate benign tumors and remain quiescent for a great while, the sufferers would unhesitatingly consent to the removal of these morbid growths in their inception, long before the possible advent of serious mischiefs, or when the cure might be effected by minor operations which would leave the smallest scars, especially in such parts as the face, neck, arms, or hands.

In the discussion of the initial question the following points

* Studies in Ancient History.

† The original paper appeared in the New York Medical Journal, November 26, 1892.

are considered: 1, The relative frequency of malignant and benign tumors; 2, the liability of the transformation of benign into malignant tumors; 3, the impropriety of delaying operative interference; and 4, the advantages of early operations.

1. The testimony of careful observors tends to show that the malignant tumors exceed the benign in frequency, and also that many malignant tumors remain stationary and seemingly harmless for one, two, six, eight years, and even for longer periods, then increase rapidly, and soon contaminate the system. (Then follow technical and statistical considerations in substantiation of these propositions.) Twenty-four per cent of all cancerous tumors affect the breast. Benign tumors of the breast are most frequent before the age of forty, and cancerous tumors of the breast are most frequent after the age of forty. Cancerous tumors are very much more frequent in the female than in the male sex. The discrimination of malignant and benign tumors at the bedside is often so difficult that surgeons are justified in advising immediate extirpation and in relying upon the microscope to insure the diagnosis and establish the prognosis.

2. The liability to the transformation of benign into malignant tumors has long been recognized, but the histological demonstration of the phenomenon is modern. It has happened that some tumors have been excised during their transition from the benign to the malignant type, and that this metamorphic process has been verified by careful microscopical examination of different parts of the growths. But so far it has not been possible to determine the precise time of the beginning of the transformation. Warts, moles, and other benign growths upon the face or body have been observed to undergo cancerous metamorphosis many years after their appearance. Fibrous and fatty tumors are often transformed into malignant tumors. So long as a tumor retains a comparatively high degree of organization it remains benign; but when its constituent tissues are disturbed, there is apt to be an accession of tissues of a low grade of organization and the tumor becomes malignant; the lower the organization the greater the malignity.

3. In stating the reasons why he believes it improper and unwise to delay operative measures for the cure of tumors, the author discusses the methods of general and local treatment employed. He considers some of them delusive, and others directly harmful, particularly the escharotics, which he thinks should be condemned. The anciently promulgated precept, that so long as a tumor is causing no apparent mischief and shows no disposition to increase in size it should not be disturbed, is still regarded by many as conservative, and commonly followed to the letter in the management of tumors. In accordance with the light thrown of

late upon the natural history of tumors, it is proper to inquire if this precept can be regarded as truly conservative. The well-known fact that any solid benign growth is liable to become malignant should be sufficient to induce surgeons to condemn the arbitrary expectancy which is so generally counseled and which so surely leads to disaster. Even if a particular tumor increases without showing signs of malignity, there can be no advantage in waiting until it shall have attained a great size, as the larger the tumor the more formidable the operation for its removal. The advice that a morbid growth should not be removed because it is stationary and causes no inconvenience does not seem to be founded on sound principles. Because it does not produce present inconvenience gives no surety that it will not sooner or later cause the greatest distress, if only from its increase in size or its interference with a vital function; but the liability to malignant transformation is what is most to be dreaded. Therefore, as a general rule, it may be considered unwise to allow any accessible tumor to so increase in size as to be damaging to the individual, or, if it be stationary, to wait until it is metamorphosed before proposing an operation for its cure. The true spirit of conservatism is manifested by advising the removal of a morbid growth when it is benign, when it is stationary, when it is small, when the operation for its eradication is trifling in comparison with what it must be when the tumor has attained a great size, or when the neighboring lymph-glands are implicated. The modern improvements in inducing anæsthesia, simplifying surgical processes, and insuring asepticism of wounds render operations safe as compared to those of former times, so that no serious harm need now be apprehended from the extirpation of most tumors. Morbid excrescences of all kinds, being worse than useless to the human economy, should be treated like foreign invaders, and removed before they become too mischievous.

4. There can be no reasonable doubt of the advantage of excising a small tumor believed to be malignant, even if this be owing only to the ease with which the operation can be executed, or to the slight degree of violence inflicted upon the parts as contrasted with the magnitude of the procedure needed for the ablation of a growth which has attained great dimensions or which has infected the adjacent lymph-glands.

For a long time there has been a prevailing belief that extirpation of a quiescent malignant tumor only serves to stimulate the extension of the disease. But this belief does not appear to have been founded upon trustworthy clinical observations or pathological data. It is undoubtedly true that any incomplete cutting operation upon a malignant tumor, or its partial cauterization with silver nitrate or arsenic, only serves to stimulate its

extension; but complete extirpation with the knife, including the adjacent connective tissue and lymphatics, leaves behind no disease to be extended. Recurrence of the disease in this case would take place after cicatrization of the wound, and would be by new cell proliferation and not by extension. External cancerous tumors have been excised, and in the course of a few weeks the patients have died of internal cancer; but in such cases, if the internal had not antedated the external disease, the metastatic process had surely begun before the operation, and would scarcely have occurred had the tumor been excised five or six months before.

Since it appears from analysis of the observations of surgeons of long and vast experience that a large proportion of benign tumors in time become malignant, and that most malignant tumors have a stage of benignity, there should be no hesitation in advising the extirpation of these tumors as soon as discovered, and this advice may be regarded as the very essence of conservatism and of prophylaxis. From a purely æsthetic point of view it is of no little consequence to minimize scars resulting from the excision of tumors of the face, neck, arms, or hands, particularly those occurring in the gentler sex, and this can be best accomplished by the timely removal of such morbid growths as are likely to increase to the extent of greatly disfiguring the patients. It should, however, be noted that almost any scar is better than an ugly tumor.

The nævi that appear upon the faces of infants, though benign, often grow so rapidly as to constitute serious disfigurement, and to require operations which leave extensive scars. If before these little vascular tumors cover a space of more than two or three millimetres they are promptly destroyed with the thermocautery, the ensuing scar is likely to be almost imperceptible. The operation is completed in a few seconds, and the pain is very slight.

The greatest mischief arises from temporization in the case of small epithelial growths upon the lip. Any tumor of the lip of doubtful character should unhesitatingly be removed. As a general rule, the subsequent dissection and microscopical examination of the tumor shows the operation to have been justifiable. Early excision is the surest means of obtaining a long period of immunity from recurrence. The period of immunity from recurrence after operations is very variable even in the same species of tumors. Thus, in cancer the average is stated by some observers to be three years and a half, and by others seven years; the extremes are three months and forty years. The writer has reported cases in which the periods of immunity varied from seven to forty years. As soon as a tumor recurs, when it is still small,

painless, and apparently harmless, it should be extirpated. The moral effect of this timely operation is generally good, bodily comfort is thereby promoted, and life is prolonged. It is therefore wise to operate as often as the tumor recurs.

According to the observations of many experienced surgeons, the average duration of life is a little less than three years from the first appearance of the tumor in cases of breast cancers that have not been subjected to any treatment. Does this not indicate the wisdom of prompt action in the great majority of cases, since the shortest average duration of life after operations which were not performed during the stage of benignity of the tumors is three years and a half, and since it has been shown that early operations afford the best chance for many years of immunity from recurrence?

Very large tumors are now rarely seen in comparison with the great numbers recorded before the introduction of ether, nitrous oxide, and chloroform as anæsthetic agents. The dread of surgical operations was formerly so great that patients were ready for the use of any means proposed rather than the knife, although many of the modes of treatment employed were cruel in the extreme, far exceeding any torture that could have been inflicted with cutting instruments. Thanks to the several modern modes of inducing anæsthesia, the patients of to-day need have little fear of the knife, for they are assured that they will be rendered insensible to pain during and for a time after operation. The surgeon, conscious that he is inflicting no pain, is then able to give his whole attention to the work in hand, and performs the operation in accordance with the recent improvements in surgical procedures and with the best modes of insuring asepticism of the wound.

The categorical answer to the initial question is, that at the earliest period of the development of any accessible tumor its complete extirpation is not only justifiable, but should be regarded as an eminently conservative and equally humane act.

As described by Mr. C. Willard Hayes, of the Schwatka Exploring Expedition, the southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which none perhaps have an altitude of more than eight or nine thousand feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated at varying distances by numerous deep fiords. From the head of Lynn Canal northwestward the range decreases in altitude and probably spreads out and merges in the broken plateau which occupies the eastern part of White River basin. This region is practically unknown, however, and the precise relation of the Coast Range to the St. Elias Range has not yet been determined.

THE EVOLUTION OF CIVILIZATION AND THE ARTS.

By M. GUSTAVE LE BON.

WE sought to show, in an address on the Influence of European Civilization on Colonies (1889), that civilized nations can not impose their civilization on the lower races, and to demonstrate the insufficiency of education, institutions, or creeds to change the social condition of inferior peoples. We maintained that all the elements of a civilization correspond with certain modes of feeling and thinking, or with a mental constitution representing the past of a whole race, the hereditary motives of conduct resulting from the experience and acts of a long series of ancestors. Only centuries, not conquerors, can essentially transform these. We held, further, that a people can rise in civilization only by a series of steps; and that, if we try by educating them to evade those steps, we only confuse their morals, and leave them at a lower level than the one they had themselves reached. And we assumed that the Arabs are the only modern people capable of civilizing inferior peoples, because they alone still have extremely simple institutions and creeds. I intend now to make the question general, and to show that the higher races have never been influenced by a foreign civilization more rapidly than the lower races; and that if they have sometimes adopted creeds, institutions, languages, and arts different from those of their ancestors, it was not till they had slowly and profoundly transformed them and brought them into relation with their mental constitution.

History appears to contradict this proposition on every page, and to show us peoples who have changed the elements of their civilization and adopted new religions, languages, and institutions; but a closer examination of these supposed changes shows us that, while the names of these things may have been changed with great ease, the realities concealed behind the names have continued to live, and have been transformed only with extreme slowness. The theory is likely to appear most paradoxical in the case of religious creeds; but, in fact, we find some of the most striking verifications of it in them. Everybody knows that all the great religions—Brahmanism, Buddhism, Christianity, and Islam—have provoked conversions of entire races, which have come over to them all at once. But a close study will convince us that in these cases it has been the name of the religion and not the religion itself that has been changed; and that the newly adopted creeds have suffered modifications that would bring them into conformity with the old creeds they replaced, and of which they were simply the continuation, and this sometimes to such an

extent that they no longer have any visible relationship with the creeds of which they keep the name. Thus, the Buddhism of China is so different from the Buddhisms of other countries that it is hardly recognizable as the same religion; and the Buddhism of India is different from that of Nepaul, and that is far removed from the Buddhism of Ceylon.

Brahmanism, too, exhibits various aspects among the different races of India, of which it is the nominal religion. All these peoples doubtless regard Vishnu and Siva as their chief divinities, and the Vedas as their sacred books; but the chief divinities have impressed only their names, and the sacred books only their texts, on the religion. By their sides are innumerable forms of worship in which we find, among the several races, the most various beliefs—monotheism, polytheism, fetichism, pantheism, ancestor-worship, devil-worship, animal-worship, etc. The titles of the sacred books are venerated by all Brahmans, but of the religion they teach there is none.

Islam has not escaped this law, even though its monotheism be so simple. It is a long distance from the Mohammedanism of Persia to that of Arabia and that of India. Polytheistic India has found a way to make the most monotheistic of creeds polytheistic. To the fifty million Mussulmans of India, Mohammed and the saints of Islam are only new gods added to thousands of other gods. Islam has not succeeded in establishing in India that equality of all men that has made its success everywhere else. The Mussulmans of India have their castes, like the Hindus. In Algeria, the Arabs and the Berbers are both Mussulman; but the Arabs are polygamous, while the Berbers are monogamous, and their religion is simply a fusion of Islam with their ancient paganism. The religions of Europe are not exempt from this law. As in India, the dogmas established by Scripture remain inviolate, but they are merely vain formulas which each race interprets in its own way. Under the general denomination of Christians we find real pagans, like the Bas Breton, praying to idols; fetich-worshipers, like the Spaniard, adoring amulets; and polytheists, like the Italian, worshiping the Madonnas of each village as different divinities. Pursuing the subject further, it would be easy to show that the great religious schism of the Reformation was the necessary consequence of different interpretations of the same religious book by quite different races—the peoples of the north of Europe desiring to discuss their creed and regulate their lives for themselves, and those of the south being more backward than they in independence and philosophical spirit.

The same rule as with religions prevails with institutions and languages. They can not be transmitted without becoming modified. Consider how often in modern times the same institutions, im-

posed by force or persuasion, have been transformed according to races while keeping identical names. The Spanish-American republics adopted the democratic Constitution of the United States; but with those races that form of organization, which had made the United States so great, was quickly transformed into a rule of bloody dictatorships and frightful anarchy. A people may, in an extreme case, forcibly impose its institutions on a different race, as England has done in Ireland, but decadence is the result to the subjected people.

So language, even though it be fixed by writing, is necessarily changed in passing from one people to another; and this is what renders absurd the idea of a universal language. It is true that the Gauls, notwithstanding the superiority of their numbers, adopted the Latin language within two centuries of the conquest; but they soon changed it to suit their wants and their special mental moods, and the French resulted at last—an idiom very different from the Spanish and Italian, though having a common origin with them. In India, with its numerous and various races, there are said to be two hundred and forty languages, some of them differing from others as much as French from Greek, and three hundred dialects. The most generally prevalent of them is modern, being only three hundred years old—Hindustani, formed by the combination of the Persian and Arabic of the Mussulman conquerors with the native Hindi. Conquerors and conquered quickly forgot their own language to take up a new one adapted to the conditions of a mixed people.

These brief illustrations, which could be extended indefinitely, show how deep are the transformations to which peoples subject the elements of a civilization which they borrow. The loan often seems considerable because the names change abruptly; but it is always, in its beginnings, really very small. In the course of centuries, by the slow labors of generations, the borrowed element, with the successive additions made to it, at last differs much from that for which it was substituted. History, which regards words most, takes hardly any account of these successive variations; and when it tells us, for instance, that a people adopted a new religion, we conceive at once, not the creed that was really adopted, but the religion as we know it now. A close study of these slow adaptations is necessary for the proper comprehension of their genesis and of the differences in the case between words and realities.

The history of civilization is thus composed of slow adaptations, of successive minute transformations. If they seem sudden and considerable to us, it is because, as in geology, we suppress the intermediate phases, and regard only the extremes.

However intelligent and well endowed we may suppose a peo-

ple to be, its faculty for absorbing a new element of civilization is always very restricted. Even the Greeks, the most intelligent people of antiquity, in the evolution of their arts needed centuries to advance beyond gross copies of Assyrian and Egyptian models and arrive by successive stages at the achievement of the masterpieces that have immortalized their name.

Yet the peoples which have succeeded one another in history—excepting a few primitive nations like the Egyptians and the Chaldeans—have had little else to do than to assimilate, by transforming them according to their mental peculiarities, the elements of civilization that constituted the heritage of their past. The development of civilization would have been infinitely slower, and the history of nations would have been only an eternal new beginning, if they had not been able to profit by previously elaborated materials. The civilizations created by the inhabitants of Egypt and Chaldea seven or eight thousand years ago have constituted a source whence all peoples have drawn in their turn. Greek arts were derived from the arts created on the banks of the Tigris and the Nile; the Roman style from the Greek; and the Roman style, admixed with Oriental influences, gave birth in succession to the Byzantine, Romanesque, and Gothic styles, according to the genius and the age of the peoples among whom they were developed. What we have said of the arts is applicable to all the elements of a civilization—institutions, languages, and creeds. The languages of Europe are derived from a mother-language formerly spoken on the central plateau of Asia; its laws from the Roman law, which was in its turn derived from anterior laws; its religion from the Jewish religion, associated with Aryan creeds; and its sciences would not be what they are but for the slow labor of ages. We can discern, despite the great gaps of which there are many in the history of civilization, a slow evolution of our knowledge that leads us across ages and empires to the dawn of those ancient civilizations which the modern science of the day is trying to connect with the primitive times when mankind had no history. But, while the source is common, the transformations—whether progressive or retrogressive—which each people, according to its mental constitution, has imposed on the borrowed elements, are very diverse; and the history of these transformations constitutes the history of civilization.

Before considering the transformations which arts, like other elements of a civilization, have suffered in passing from one people to another, let us ask to what extent they are the expression of a civilization. Writers on art are accustomed to say that they faithfully reflect the thought of the people, and are the best expression of their civilization. This is doubtless often the case,

but the rule is far from being general, and the development of the arts does not always correspond with the mental and social development of nations. While there are peoples to which works of art are the most important manifestation of their genius, there are others high in the scale of civilization with which art has only played a secondary part. If we were obliged to write the history of the civilization of each people, and could take one element, that element would vary from one people to another. It would be arts for one, political or military institutions, or industries, by which others would be known best. This fact will account for the arts having suffered very unequal transformations in passing from some peoples to others.

The Egyptians and the Romans, among ancient nations, present characteristic examples of inequality in the development of the different elements of their civilization, and even of the different branches of which each of these elements is composed.

The Egyptians were weak in their literary efforts, and their paintings were mediocre, but in sculpture and architecture they produced masterpieces which the Greeks were able to excel during only a short period of their history.

The Romans were not in want of teachers or of models, for they had the Egyptians and the Greeks, but they never succeeded in creating an art characteristic of themselves; no people perhaps ever betrayed less originality in their productions in this field. But they raised the other elements of civilization to the highest point. Their military organization assured them the domination of the world; their political and judicial institutions are still patterns for us; and their literature inspired the centuries that followed them.

The Greeks, who manifested the highest superiority in the most diverse branches, may likewise be cited to prove the want of parallelism between the development of the various elements of civilization. Their literature was already brilliant in the Homeric epoch; but modern discoveries in archæology show that in the same period their sculptures were grossly barbaric, and were simply crude imitations of Egyptian and Assyrian work.

The Hindus most pointedly illustrate this inequality of develment. Few peoples have equaled them in architecture; in philosophy their speculations go to a depth to which European thought has only recently arrived; in literature they produced admirable works, even though they fell short of those of the Greeks and Latins. But they were mediocre and far below the Greeks in statuary, and were nullities in the domain of scientific and historical knowledge, while they betray an absence of precision which we meet in equal degree among no other people.

There are, further, races which, without ever having occupied

a position in any way superior, have been able to create an individual art free from apparent relationship with anterior models. In less than a century after they conquered the Greco-Roman world, the Moslems had transformed the Byzantine architecture which they adopted, so greatly that it would be impossible to discover by what types they were inspired, if we had not the series of intermediate monuments under our eyes.

Even a people possessing no artistic or literary aptitude may create a high civilization. Such were the Phœnicians, who had no superior gift except their commercial skill. They promoted civilization by bringing different parts of the world into relations, while they produced nothing themselves, and the history of their civilization is nothing but the history of their trade.

There are, finally, people that stand low in all the elements of civilization except art, as the Moguls, whose monuments in India, with hardly anything of the Hindu about them, are so splendid that competent critics have declared them the finest works that have been raised by human hands; but nobody would class the Moguls among the higher races.

It is further to be remarked that, even with the most civilized peoples, the period when art attains its highest degree of development is not usually at the culminating epoch of their civilization. The most perfect works of the Hindus and Egyptians are generally the most ancient; and that remarkable Gothic art, the admirable works of which have never been paralleled, flourished in Europe in the semi-barbarous middle ages. It is, therefore, impossible to judge of the degree of a people's advancement solely by the development of its arts, which constitute only one of the elements of its culture, and that one which has not been shown, any more than has literature, to be the highest. It is, on the contrary, sometimes the case that peoples at the head of civilization —as the Romans in ancient times and the Americans in modern— are weakest in works of art, while other peoples have produced their highest literary and artistic masterpieces in their half-barbarous ages.

The period of individuality in the art of a people appears, therefore, to be a blossoming of its infancy or its youth, and not of its mature age. There are many other evidences that the progress of the arts is not parallel with the advance in the other elements of civilization, but that they have an independent and special evolution. It is a general law that when art has reached a certain level, marked by the creation of high masterpieces, a period of imitation sets in, followed by a period of decadence, both of which are independent of the course of the other elements of civilization. This lasts till some revolution or innovation, the adoption of a new creed, or some like factor intervenes to introduce new elements,

as did the Crusades in the middle ages, the revival of Greek and Latin studies in the Renascence, and the Mussulman conquest in India.

It is also to be remarked that as art in a general way reflects certain wants and corresponds with certain sentiments, it is destined to share their fate, and therefore to vanish when they cease to be vital; but that condition is no sign of a decay of civilization. At no period has civilization been as high as now, and at none has art been more commonplace. From a spontaneous outgrowth of the devotion of the past it has become an accessory, a thing of luxury and convention, imitative rather than original. No people of the present has a national art, but all are contented with copies of the models of past ages.

If we study the shapes in which architecture, for instance, has been transmitted from one people to another since its historical beginning with the Egyptians, we shall find that in the hands of an inferior race—the Ethiopians, who, although they had centuries to work in, were deficient in cerebral capacity—it tended to inferior forms; while with the Greeks, a higher race, whose development also occupied several hundred years, it was improved upon and raised to a much higher level. The Persians, an inferior people to the Greeks, and whose independent career was much shorter, displayed considerable talent for adaptation, and were beginning to work a transformation in their art, when they were overthrown. A thousand years later they rose again, and devised an architecture having the stamp of originality, but combined with it marks of the influence of the ancient art and of the more recent Arabian art.

Another more modern school of architecture, of which specimens are yet standing, strikingly illustrates the extent to which a race modifies the arts which it adopts. The example is all the more typical because it is drawn from a group of peoples professing the same religion but having different origins. I mean the Mussulmans, whose structures in Spain, Africa, Syria, Persia, and India present so considerable differences that it is impossible to arrange them in one class as we do the different styles of the Gothic. The correctness of this illustration is enforced by a reference to India, where, although the same religions and the same rule prevail throughout the land, the temple in the north and the pagoda in the south, consecrated to the same divinity, are as different from each other as a Grecian temple and a Gothic cathedral. This great peninsula furnishes the most suggestive and the most philosophical of historical books. It is now, in fact, the single country in which we can, by simple changes of place, transfer ourselves at will into different periods of time and observe still in life the series of successive stages which mankind has had to pass

through to reach the higher levels of civilization. All the forms of evolution can be found there, from those representative of the stone age to those of the age of steam and electricity.

In this essay I have endeavored to set forth the principles: that the various elements, the aggregation of which constitutes a civilization—especially institutions, creeds, and arts—are the expression of certain modes of thinking and feeling special to each race, and inevitably suffer transformation in passing from one race to another; that they rarely undergo a parallel development among different races. With some, institutions—with others, literature, industry, or art—prevail. One or several of these elements may remain at an inferior level in the midst of a brilliant civilization, or it may stand high in a low civilization. Of all the factors having an influence on the adoption and evolution of the fundamental elements of a civilization, the most important is race. It holds a position much above that of the influence of political institutions, conquest, or religious belief, which is powerful everywhere else. When a people of a much higher race is in contact with a people of a much lower race—as the whites with the negroes—the latter can not immediately acquire anything useful from it. Two superior races confronting one another exert no action upon each other when, in consequence of differences in mental structure, they have incompatible civilizations. This condition exists when a highly civilized people finds itself in contact with a people having a very ancient and very different civilization, as when modern Europeans are brought into contact with the Hindus or the Chinese. When civilizations possessing compatible elements, like those of the Mussulmans and the Hindus, meet, they first overlay one another and then fuse as to their compatible elements. The civilizing action which some peoples can exercise upon others has been more profound the further we go back in history, because the elements of civilization were less complicated in ancient times than now. This power of action has been reduced from age to age.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

M. PERROTIN, a French astronomer, records several observations of luminous protuberances escaping from the disk of Mars, near the fiftieth degree of southern latitude, resembling what would result from the escape of a flow of matter from the planet. The author held the publication of his discovery in reserve for some time, apprehending that there might be some mistake about the matter, but, convinced at last of the reality of the appearance, communicated the fact to the French Academy of Sciences on the 5th of September. No adequate explanation has been offered for the phenomenon, but the discoverer suggests that it may be connected with the luminous points that may be distinguished on the disk of the planet.

A CAPTIVE COMET.

By CHARLES LANE POOR.

ON the night of June 14, 1770, the great French astronomer Messier first saw the captive comet. It then appeared as a small patch of haze against the cloudless sky, but it rapidly grew larger and more brilliant, until, on July 2d, when it passed nearer to the earth than any other known comet, it was as bright as the North Star, and its diameter was twice that of the full moon. From that moment its brilliancy faded, it grew fainter and fainter, and was seen for the last time on October 2d.

While this comet of 1770 is one of the most famous in the annals of astronomy, it owes its celebrity not to the spectacular effects it produced, for it was not one of those magnificent objects that stretch across the heavens, exciting the wonder and admiration of the intelligent, the fear and dread of the ignorant. Its fame is due to its mathematical history, to the path it was then traveling, and to the path it has since traveled. Only twenty years had elapsed since Halley had made his great discovery of the existence of periodic comets, and this comet of 1770 was shown by Lexell to belong to this interesting class of bodies, to be then revolving around the sun in an ellipse of five and a half years. To the conclusions of Lexell it was at once objected by other mathematicians that if this comet revolved about the sun in an ellipse, like the planets, it should have been seen six years before, and again, six years before that; at least, some record of its former appearances ought certainly to be found. As there were no such records, as it could be shown that there was no comet that had appeared regularly every five and a half or six years, Lexell's opinions were for the moment discredited. However, he soon conclusively proved that he was right, that the comet was moving at the moment in an ellipse such as he had described, but that it had not always traveled in that same path. He showed that in 1767, or only three years previously, the comet had passed very close to the giant planet Jupiter, and that then its path had been greatly altered, so completely changed, indeed, that never before had it passed near enough to the earth to be seen. He also predicted a second close approach of these two bodies in 1779, and said that this circumstance might prevent the reappearance of the comet after that date. This prediction of Lexell's was fulfilled, for the comet was never again seen, unless it prove that the comet discovered by Brooks on July 6, 1889, is the lost body.

On that summer evening, at Geneva, N. Y., Brooks discovered a faint telescopic comet, since known as comet *d and V*, 1889. As this body never became visible to the naked eye, it received but

passing notice from the daily newspapers; even astronomers, at first, thought very little of it, as the discovery of a new comet is now a matter of almost monthly occurrence. It was not long, however, before this body began to attract the attention of the scientific world, and it was soon recognized as a permanent member of the solar system; and now, through the researches of Dr. Chandler and others, it has become the most famous comet of this century. It has been identified with the lost comet of Lexell, which disappeared one hundred and twenty years ago.

Upon what grounds do we base this conclusion? A comet was seen for but a few months during the summer of 1770, another one is observed during the summer and fall of 1889, and it is asserted that these two bodies are identical. There are no physical means by which they can be identified, for comets have no permanent characteristics which, when once seen, can always be recognized. Indeed, to all appearances, these two bodies were utterly unlike: the comet of 1770 was large and bright, with a well-marked tail; while the comet of 1889 was hardly visible even with powerful telescopes, and then appeared but as a small patch of haze against the dark sky. If, then, we rely on similarity of appearance to establish the identity of these two comets, we should fail to do so, and would be forced to conclude that they are not the same. But by a study of the movements of the two, especially of the latter, it can be shown that they must have occupied, at one time, the same position in space—their identity is then self-evident.

At present the comet is moving in a small ellipse of about seven years' period. This path is shown in the diagram. The smallest circle represents the annual orbit of the earth around the sun. Just outside of this circle is a heavily drawn ellipse with one of its foci at the sun. This is the present orbit of comet V, and on it are marked three positions of this interesting body. The first, July 6, 1889, marks its position on the night of discovery; the second, September 30th, at its perihelion passage, or nearest approach to the sun; the third, that of December, 1890, the position it occupied when last seen. For months before this last date, however, the comet could only be seen by means of the great thirty-six-inch Lick telescope. Between the two extreme positions above mentioned, there are scattered along the curve some two hundred and fifty other observations; and on this small part of the comet's path rest all the conclusions as to its movements for over a hundred years.

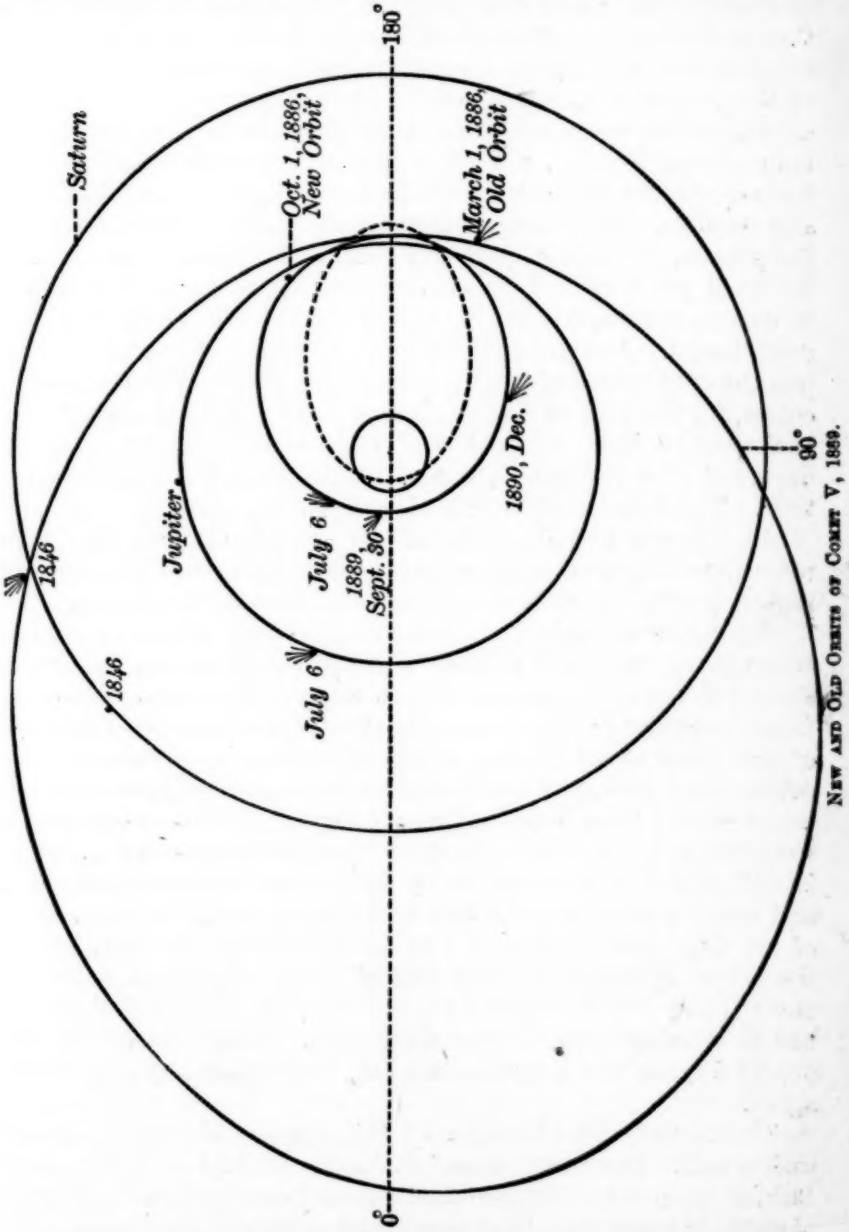
The first step in the problem was to deduce from these observed positions the orbit of the comet, or the ellipse shown in the diagram. This curve should be clearly understood—it is *not* the *actual path* of the comet through the heavens, but that path

which it would describe if the comet and sun were the only two bodies in existence. The earth, Jupiter, all the planets are, in fact, pulling and hauling at the unfortunate body: first one drags it a little one way, then another pulls it in a different direction. The real path of the comet about the sun is, then, a very complicated, wavy sort of a curve, which, as a rule, does not depart very much from the ellipse above figured.

Now, while mathematicians have succeeded in completely solving the problem of two bodies, yet, up to the present day, that of three or more bodies is still unsolved. If the sun and comet were the only two bodies in the universe, then could a mathematician, after a few moments' calculation, predict exactly where each would be a thousand years hence; could tell where they were ten thousand years ago. But as soon as there is introduced into such a simple system the earth, Jupiter, and the other planets, our mathematics fails to give a complete solution. All that can be done is to trace the course of the comet step by step, day by day, almost. We know its position to-day, and we can accurately calculate the direction and the amount of the pull of each planet; hence, we can find where it will be to-morrow, and, by repeating the process, where it will be the next day, and the next. Of course, this is a very laborious process; the calculation of the pull of a single planet requires the writing and the combination of one hundred and fifty numbers of six figures each. But, fortunately, the sun is over a thousand times as strong as the great planet Jupiter, and over three hundred thousand times as strong as the earth; so that, unless the comet approach very near to one of the larger planets, it will never deviate much from its simple orbit around the sun. The steps in our computation may be, therefore, lengthened. The ordinary length of step in such work is forty days; and, in a first computation, the pulls of the smaller politicians—as the earth, Venus, and Mars—can be neglected beside the very strong ones of Jupiter and Saturn.

As we wished to trace the history of comet V, we started with the earliest observed position, that of July 6, 1889, and we began by taking steps of forty days each. Thus the path the comet had traveled was slowly traced backward, and it was found to approach nearer and nearer to Jupiter. Proceeding backward thus over a period of two years, we find that in March, 1887, the pull of Jupiter was so strong that, in order to keep the work at all accurate, we were obliged to shorten the steps to ten days. Continuing thus, the pull of Jupiter grew stronger and stronger, until, in October, 1886, it was actually greater than that of the sun, and a change of method had to be used in order to trace the path beyond that point, and with this change in methods appears the interesting mathematical part of the problem.

It is now perfectly well known to every schoolboy that the sun is the center and ruler of the solar system; that the earth and other planets revolve about it in great ellipses. This simple fact



was not recognized, however, until nearly the middle of the sixteenth century. For thousands of years previously, astronomers as well as priests, the educated and the ignorant, had thought

that the earth was the center of the universe; that the sun, the planets, and the countless stars revolved around and were accessory to this little abode of man.

Ptolemy, the greatest astronomer of the ancients, put this false theory on a strict mathematical basis. By means of his cumbersome system of epicycles he could roughly compute the positions of the planets at any time, could foretell the time of rising and setting of the moon, and predict eclipses. But, while the Ptolemaic system is false, while it does not agree with what we now know to be the true system of the heavens, yet it is mathematically possible. In discussing the various positions and motions of the planets, it would be perfectly possible to consider the earth as the fixed point around which they move; we could thus arrive at correct results, but the processes would be infinitely long and complicated. And yet a modification of this antiquated method was the only means of tracing further the path of this interesting comet, for the pull of Jupiter became now so strong that, in our backward path, we would have had to take steps, not of a few days, not of a few hours, but of twenty or thirty minutes at a time. The task would have been endless.

Jupiter was now the ruler of the comet's destiny, the sun a mere disturbing element, so that it became simpler to give Jupiter its just position as ruler at the center of the comet's motion.

Jupiter was made the momentary center of the universe; comet, sun, earth, and planets were all considered as revolving around this monster planet. The change of the center of motion from the sun to Jupiter was easily effected, and the resulting orbit of the comet about Jupiter was found to be a hyperbola, an open curve. And now, just as before, this curve is merely the path the comet would have described about Jupiter if it and the planet were the only two bodies in existence; the long-suffering comet is still pulled and hauled at by various bodies, notably the sun, and step by step its path had to be traced out. At first, steps of ten days each were found to be sufficiently accurate, but as the comet approached closer and closer to Jupiter it began to move faster and faster, and consequently the length of the steps had to be shortened to four days each. After the comet had passed Jupiter the length of the steps was gradually lengthened again.

The remarkable character of this appulse should be clearly understood. The comet passed the center of Jupiter in 1886, July 19th, at no greater distance than two and one third radii of that planet. It must then have passed the surface of Jupiter at a distance of only one and one third radii—that is, the center of the comet was only about sixty thousand miles from the surface of the planet. It is not at all improbable that parts of the diffused

mass of the comet swept over the surface of Jupiter itself, and that we had here a true collision between the two bodies. The comet struck the planet a glancing blow, as it were. As is usual in all collisions, the weaker body suffered: the comet was broken into three parts, while Jupiter was unharmed.

When the comet had passed far enough away from Jupiter, so that the sun had regained its supremacy, the motion was again referred to the sun as fixed point, and the tedious process of tracing the comet's history continued, step by step. Tracing thus backward the path of this minute body, we find that it leads to the spot where Lexell's comet disappeared in 1779. Either two comets can occupy the same space at the same time, or the comets of 1770 and 1889 are one and the same.

We have thus seen something of the laborious process by which, starting with a few observed positions of a body in 1889, we can trace the path it has traveled for one hundred and seven years; how we can show its identity with a comet seen in 1770. Of the path itself but little has yet been said. It is interesting. And as it is always easier to trace a succession of events in the order in which they occur than it is to reverse the order of time, we will start with the first recorded public appearance of the comet, in 1770, and give a brief sketch of its erratic course through the heavens since that moment—though, remember, this path was discovered by tracing the body backward along its course.

Look again at the diagram. In the summer of 1770 the comet was seen moving along the small dotted curve in the region very close to the smallest circle in the diagram, which represents the orbit of the earth. It disappeared from view and passed outward along this dotted curve, making one complete revolution, returning in 1775 to the point where it was first seen. During these few years the earth had also been traveling its yearly path around the sun, and it so happened that in this latter year (1775) the earth had moved into a different position in its orbit, so that the sun was directly between it and the comet. The comet was therefore not then seen. Onward went the comet along this dotted path, until, in 1779, it had reached the outermost point, when it encountered Jupiter. The effects of this appulse were very marked as regards the comet: it was pushed completely out of its path and set moving in an immense ellipse, the one that extends far out to the left in the diagram. From five and a half years its period had been changed to about thirty-four years. In this large path this captive body moved without any extraordinary incident for sixty-seven years, or until 1846. During this time it had traveled twice around the curve, and it was fairly started on its third trip, when Saturn took a hand in the game and altered its path considerably, extending the ellipse to one of forty-seven years period. On it

went, but it was never allowed to complete even one revolution in this last ellipse, for in 1886 it collided with Jupiter, as has been already described, and its path was changed to the small ellipse in which the justly famous comet is now moving, and in which it will continue to move for a number of years to come.

THE INVENTOR OF THE LIGHTNING-ROD.

By JOSEPH J. KRÁL.

WHEN the newspapers lately announced the names of eminent electricians which are to adorn the Electrical Building at the Columbian World's Fair in Chicago in 1893, we were surprised, nay, disappointed, to find that the respective officials left out the name of a man of science whose merits would fully entitle him to that honor. We mean Prokop Divis, the man who, before Franklin, discovered the identity of lightning and electricity, and the issuing of electricity from metallic points, two important truths which led him to construct a lightning conductor. But his modesty (he was a Catholic priest and a thorough scholar), and the ignorance of others combined, caused his name nearly to be forgotten. The Encyclopædia Britannica knows nothing of him, while the German Conversations Lexicon of Brockhaus (Volume V, page 406) disposes of his two great discoveries exactly in two sentences. The only mention of him we find in English literature is a short sketch in the Historical Magazine for February, 1868 (page 93, article xii), which is a translation from a French periodical. As the life of Divis is of itself sufficiently interesting, we hope to be justified in presenting a few more details of his life to the readers of this magazine. Our article is based chiefly upon a sketch in the Bohemian Encyclopædia of Rieger and Maly (Volume I, pages 209, 210, and Volume III, page 941).

Prokop Divis (Dyiv'ish) was born on the 1st of August, 1696, in the town of Zamberk (its German name is Senftenberg), in northeastern Bohemia, of Bohemian parents. At the gymnasium of Znojmo he received the rudiments of higher education, and afterward entered the Premonstratensian order at Luka. On November 30, 1720, he bound himself with the three monastic vows, and six years later took the holy orders. On account of his high scholarship, he was soon after appointed Professor of Philosophy in the Lyceum of Luka. A special feature of his lectures were various experiments in physics, with which, contrary to all precedents, he liked to illustrate the subjects discussed. It will be remembered that the Church has never looked with favor

upon natural sciences. After a year had passed, Divis was obliged to change his subject and lecture on theology. He distinguished himself also in this new field, and accordingly, on the 5th of August, 1733, the University of Salzburg conferred upon him the degree of Doctor of Divinity.

He had been longing for an opportunity to devote himself to scientific research. His wishes seemed to be fulfilled when he was ordained parson of the parish of Prendice (Pren'dyitsch), a small village in southern Moravia, near the city of Znojmo (Znaim on English maps). Here all his leisure was given to physical experiments; with especial care he studied the properties of water and fire (oxidation). In 1741 he became prior of the Lukan Convent, and consequently had to discontinue his scientific labors for a few years, as the duties of the new office required all his time. Besides, the Austro-Prussian War had just broken out,* and a double care devolved upon the shoulders of the new prior. Throughout the war Divis faithfully performed his duties, but as soon as peace was restored to Moravia he resigned his dignity and returned to Prendice to resume his favorite work. His parish was a small one, and thus Divis was enabled to spare time enough for scientific inquiries. He now entered upon an examination of electricity. Pursuing the safe empiric method, Divis based all his conclusions and estimates upon careful experiments. His observations of thunderstorms led him soon to a discovery that lightning was but an electrical spark—that in his laboratory he could imitate thunder and lightning on a small scale—and he resolved to try if it were possible to make thunderbolts harmless. How thorough his studies were, may be gathered from the fact that he worked out a complete theory of atmospheric electricity, a treatise on which was published from his papers after his death.

Another important discovery followed soon after. Divis found out that metallic points would both attract and discharge electricity more speedily than anything else, and proceeded to make a practical application of the newly discovered truth. About the same time Franklin, on this side of the Atlantic, was receiving his first lessons in electricity from Dr. Spence.

The fame of the electrical experiments of Divis soon reached the imperial court of Vienna, and the Emperor Francis Stephen, who was somewhat of an amateur naturalist himself, invited Divis to Vienna, to repeat his experiments in the halls of the

* Charles VI, King of Bohemia and Hungary and Emperor of Germany, died in 1740, leaving his dominions to his daughter Maria Theresa. Frederick the Prussian thought this a good opportunity to rob the queen of some of her territories, and he immediately, without any right, and without even a declaration of war, invaded Silesia.

imperial castle. These performances were also honored by the presence of the Empress Maria Theresa. The imperial couple were highly pleased with the experiments, and, to show their esteem for Divis, they presented him with two heavy golden medals with their busts engraved upon them.

In 1750 Divis demonstrated his superior knowledge of electricity in an amusing way. Father Francis, a learned Jesuit, was about to make some experiments with his electrical machine at the Vienna court. While he was making some preliminary remarks, the Bohemian scholar, who had concealed a number of small iron nails in his periwig, approached the machine and viewed it closely from all sides, as though he were going to make a critical examination of it. His true intention was, however, to take away all electricity stored on the metallic balls, in which he succeeded without touching the machine. Imagine the horror of Father Francis when he finally came to perform his experiment, and found that, although his accumulators were well insulated, all his electricity was gone!

FIG. 1.—THE TOP OF THE LIGHTNING-ROD OF DIVIS.

In 1753 Prof. Richmann, of St. Petersburg, while observing a storm from a hut, was killed by lightning descending an insulated iron bar specially erected for the purposes of the study. Upon learning of the fate of that martyr of science, Divis drew up a memoir on that unhappy occurrence, in which he demonstrated that the iron bars, as used by Richmann, were both unsafe and dangerous, and clearly showed how, in case of a storm, the danger of a lightning-stroke could be averted by means of a conductor, the idea of which had already matured in his mind. This treatise he sent to the famous mathematician and naturalist, Euler, then President of the Berlin Academy of Sciences, asking for his judgment. But his application was in vain; the Academy failed to understand his reasoning. This is one of the numerous instances which go to show that it is always the individual workers to whom we have to look for any advance in science rather than learned societies. When Franklin's account of his discovery was read in the British Royal Society, it was laughed at by the connoisseurs.

Divis was not discouraged by the cold reception with which

his work had met in Berlin, but went on to construct his lightning-rod. After all that was necessary had been prepared, the conductor was erected on the 15th of June, 1754, near the residence of the parson, for Divis, in order to avoid all risks, gave up the idea of placing the lightning-rod upon the building, but built it separately in the free field near the building. The lightning-rod of Divis was constructed as follows:

FIG. 2.—A HORIZONTAL VIEW OF THE CROSS-BARS.

A pointed, slender iron bar formed the main part of the machine. Fastened to it were two cross-bars, thus making four arms, across each of which, in turn, a shorter bar was laid. And each of the twelve extremities so effected bore a box filled with shavings of iron in which twenty-seven brass needles were stuck, making three hundred and twenty-four needles in all. The main bar was supported by a wooden column sufficiently high (forty-eight feet at first, afterward one hundred and thirty-two feet) to secure protection for the building and its immediate surroundings. Several iron chains connected the main bar with the earth. The effect of the machine was to divide the lightning into as many sparks as there were needles (three hundred and twenty-four), and thus to lessen its force. It might, therefore, more properly be called a lightning-divisor.

Scarcely had the rod been erected when a storm came rushing on from the north. Thunder-clouds hung over Prendice, and occasionally white shafts of lightning were seen darting from the clouds and flying toward the conductor. In a few minutes a white cloud enveloped the machine, and the storm soon passed away without doing any damage. For two years Divis continued experimenting with his lightning-rod; the results were published by Dr. Scrinci in the Prague News (1754). Having satisfied himself in regard to the utility of his new machine, Divis offered to the emperor a plan for erecting a number of conductors in various parts of his empire. The emperor submitted the plan to Viennese mathematicians, who were, unfortunately, a little behind the times, and reported unfavorably upon the Bohemian's proposition. The plan was consequently never carried out. Abbot Marci, speaking about the report of the Viennese "connoisseurs," says, in a letter to Divis, "Blasphemant, quae ignorant" (They blaspheme that which they do not understand). And at last, in 1756, Divis was compelled to remove his lightning-rod. There had been a very dry summer that year, which the farmers

of Prendice and the neighboring places ascribed to Divis's machine! One day an angry crowd came to the parsonage and tore down the iron bars. The authorities then ordered Divis to take away his machine, and he accordingly removed it and deposited it at Bruck, where it has been kept to this day.

There is a marked similarity between the treatment which the invention of Divis suffered at the hands of his neighbors and that accorded to Franklin's conductor in America. When, in 1755, Massachusetts had experienced a sharp shock of an earthquake, the judgment of the public opinion was pronounced upon Franklin's rods as the direct cause of the earthquake. As late as 1770 a Boston clergyman preached against the lightning-rods as "impious contrivances to prevent the execution of the wrath of Heaven." The difference between the relative positions of the two inventors was that in America a divine denounced a layman, whereas in Moravia laymen denounced a divine. We unwillingly recall the words of Mädler: "In all times and in all countries the enemies of truth and light pretend to be fighting for the honor and glory of God."

Thus Divis was prevented from perfecting his machine, which would have doubtless been wrought by him into a different, more advantageous, shape but for the official order. Divis felt himself obliged to give up his studies and experiments in electricity, and his versatile genius turned to a new field—music. He was well acquainted with acoustics, and as a Bohemian he possessed likewise a personal liking for music; and before long his creative genius enriched the musical world with a new instrument which he named "denis d'or."* This instrument is played by both hands and feet, like an organ, and it can give the sound of almost any stringed or wind instrument, from the *pianissimo* to the *fortissimo*, as it has as many as one hundred and thirty registers. In its effect this instrument is equal to a full orchestra.

This was the last great work of Divis, and on the 25th of December, 1765, the untiring worker quietly departed his life.

Personally, Divis had the true appearance of a thinker. In his early youth his health was rather delicate, but it improved steadily after he began his electrical experiments and never failed him again, although he was constantly at work. Oftentimes he was so deeply absorbed in his experiments or observations that he would not notice his friends coming to see him, until a servant reminded him of their presence by pulling his sleeve. The steady mental work gave his face a serious, unfriendly mien, which disappeared, however, whenever he happened to be in a circle of his friends. His guests, among whom there were many distinguished

* Denis is a French translation of the Bohemian name Divis. D'or means "of gold."

persons, he always entertained courteously. Besides his mother-tongue, the Bohemian, he also knew Latin, German, and French. From the papers he left there was printed, after his death, a treatise entitled Längst verlangte Theorie der meteorologischen Electricität (The Long-sought Theory of Atmospheric Electricity), Tübingen, 1768.

Prokop Divis is an interesting example of an ideal scholar. Originally he studied science merely for the sake of finding out the truth; but when he saw that the truths discovered by him could be utilized for the benefit of mankind, he utilized them. Undoubtedly he knew nothing of Franklin, and there is no evidence that Franklin ever heard of Divis; their discoveries in electricity were wholly independent of each other. But Franklin was the happier of the two because he found a people who understood him—the French; while Divis, by his social position, was prevented from perfecting his instrument. We must remember that Benjamin Franklin was a public man, who stood conspicuously before three countries, while Prokop Divis was merely a parish priest of a small Bohemian village, with few or no connections. Yet we admire his genius evinced by inventions so vastly different—a lightning-rod and a musical instrument. These are wittily characterized in his epitaph, written by one of his contemporaries:

"Ne laudate Iovem, gentes! quid vester Apollo?
Iste magis deus est fulminis atque soni."*

GENIUS AND SUICIDE.

By CHARLES W. PILGRIM, M. D.

WINSLOW, in his Anatomy of Suicide, says, "A person who accustoms himself to live in a world created by his own fancy, who surrounds himself with flimsy idealities, will, in the course of time, cease to sympathize with the gross realities of life," and any one who will take the trouble to read the biographies of men of genius will see that this statement is borne out to a remarkable degree. Probably the most striking example of this doctrine, as well as the most pathetic instance of suicide in the annals of literature, is found in the records of Chatterton's short life. From the beginning shadows hovered over him. He was the posthumous child of a poor widow, whose dead husband had been a rough, drunken fellow, and a singer and subchanter in the cathedral choir of Bristol. The mother supported herself

* "Do not praise Jove, nations! What is your Apollo?
This man, rather, is a god of both the lightning and the sound."

by dressmaking in one of the back streets of the old town, and the boy was only able to gain the rudiments of an education in a charity school. His biographer tells us that he was of a peculiar temper, sullen and silent, and given to sudden fits of weeping or violent rage. When only ten years of age he began to write verses, and although he was too shy and diffident to make a confidant of any one, his secret soon became known among the little blue-coats of Colston's Charity School. His uncle, Richard Phillips, was the sexton of the church of St. Mary Redcliffe, in Bristol, one of the most beautiful specimens of parochial church architecture in all England, and many of this strange boy's days were passed studying the inscriptions on the altar tombs and in poring over the forgotten parchment deeds which had lain for years unheeded in the oaken chests in the old muniment-room above the porch. So much of his time was spent in solitude, and he seemed to have so few of the characteristics of children, that many regarded him as weak in intellect. But even then he was thirsting for fame, and while only a child was wont to say that a man might do anything he chose. It was the accidental discovery of the old parchment deeds in the parish church that led this child of genius to perpetrate the Rowley forgeries, and to claim that these products of his own imagination had lain in the old chest for more than three centuries. Failing to obtain the patronage of Sir Horace Walpole, he determined to seek his fortune in London, and in order to obtain his release from Lambert, an attorney into whose employ he had been bound, he sat down on Easter eve, April 17, 1770, and penned his Last Will and Testament, in which he intimated his intention of committing suicide. Among his satirical bequests he leaves his "humility" to the Rev. Mr. Camplin, his "religion" to Dean Barton, and his "spirit and disinterestedness" to Bristol. This strange document had the desired effect, and Lambert canceled his indentures. So, with a light heart, a lighter purse, and a bundle of valuable manuscript under his arm, he set out, at the age of seventeen, to gain fortune and fame as a man of letters in the great metropolis. His after-life is well known. Nothing but disaster followed. He lacked the simplest necessities of life, but even when starving wrote cheerful words and sent small gifts to the mother and sister left behind. Failure met him at every hand, and by degrees he sank lower and lower into the depths of despair, until finally, with his last penny, he purchased sufficient arsenic to end his unhappy life. He was found on his cot of straw with torn manuscript all about him. Thus ended the brief, strange life of the "fate-marked babe who perished in his pride."

Another example of Winslow's doctrine is Hugh Miller, the self-taught genius, who was born at Cromarty, in the north of

Scotland, on the 10th of October, 1802. Like Chatterton, he had little patience with the schools. He would play truant in order to enjoy a book in freedom on the hill or by the sea, and his old schoolmaster feared that he would become a dunce. Curious to state, when it became necessary for him to decide upon a trade, he chose that of stone-mason so that he might be unemployed in the winter frosts, and thus have opportunity to read and write.

For fifteen years he worked in the quarry during the pleasant days of summer, and spent the hours of winter prosecuting the object of his ambition—the writing of good English. His clear, choice diction caused the Edinburgh Review to ask, "Where could this man have acquired his style?" little thinking that the greater part of his life had been spent in the quarry and hewing-shed.

His work attracted so much attention that in 1840 he was called to the editorial chair of The Witness, a semi-weekly paper published in Edinburgh for the purpose of securing spiritual independence. Unremitting labor resulted, and the night following the completion of his greatest work, The Testimony of the Rocks, he yielded to the strain to which his overworked brain had been subjected and sent a bullet through his heart.

Another similar case is that of Robert Tannahill, a Paisley weaver, who was one of the most popular successors of Burns in song-writing. He was born in 1774, apprenticed to his father's trade when twelve years of age, and composed his songs as his shuttle went to and fro. He apparently had a single love affair, which occasioned the composition of the popular song, "Jessie, the Flower of Dunblane." He was shy, sensitive, and awkward, and therefore uncomfortable except in the presence of his humble friends. His monotonous existence was broken only by occasional trips to Glasgow, and the one memorable day in all his life was when James Hogg, the Ettrick Shepherd, paid him a visit. The meeting was prolonged into the night, and the parting was painful and pathetic. Tannahill, grasping the hand of his poet-brother, said, while tears suffused his eyes: "Farewell! We shall never meet again." His words were prophetic, for shortly afterward his body was found stark and stiff in a pool near his house.

To come down to more recent times, we have but to recall the melancholy end of Richard Realf, an English peasant, born in Framfield, Sussex County, June 14, 1834. I can not better give the story of his life than by quoting freely from a letter written to Rossiter Johnson in 1875, who was at work upon a short biography of the poet for the Little Classic Series. In this letter he says: "I never received any education in my boyhood, except for a year or two at the little village school. We were a large family

and very poor, and I went to work in the fields at a very tender age." At fifteen, or thereabouts, he states that he began to write verse, "lisping in numbers, for the numbers came." When sixteen he went to visit his sister, who was a servant in the family of a physician at Brighton, and the wife of the doctor, who was a lady of literary tastes, manifested an interest in him and made him her amanuensis. A physician, who lectured on phrenology, shortly afterward became a guest of his benefactress, and learning of the young poet's ventures made use of some of them in one of his lectures to illustrate the organ of ideality. Among the listeners was Lady Byron. She with Rogers, Mrs. Jameson, and Lady Jane Pell, determined upon publishing a collection of his verses, and did so in 1852, under the title of Guesses at the Beautiful. He soon realized that he was in danger of being spoiled by condescending patronage and praise, and therefore wrote to Lady Byron, who was then at her country residence in Surrey, begging her to get him away from surroundings which might make him forget the honest peasant parentage from which he sprang. She at once made arrangements for him to go down to Leicestershire to her nephew, Mr. Noel, manager of one of her estates, where he would have opportunity to study the science of agriculture as well as to prosecute his literary purposes. Like all men of poetic temperament, he had the fatal faculty of falling in love, and an attachment soon sprang up between himself and the eldest daughter of Mr. Noel. Realizing that there was a gulf between them which could never be bridged, he determined to come to America. Reaching New York in 1854, he began to explore the slums for the purpose of writing sketches, but instead became a sort of Five Points missionary. He kept at this work for two years, and then in 1856 conducted a large number of Free State emigrants to Kansas. He became intimate with John Brown, was with him at Harper's Ferry, and narrowly escaped lynching. He enlisted in 1862 and served through the war with credit, rising by promotions to the rank of captain. The next step in his history has a local interest for us who live in the western part of New York, for in the autumn of 1867 we hear of him in Rochester writing a series of remarkable poems for the Rochester Union. It was there that Rossiter Johnson, who was then assistant editor of the Democrat and Chronicle, became interested in him, and it was also there that he contracted the unfortunate marriage which darkened his life and ultimately brought it to an end. Johnson, who has written fully of this episode, tries to excuse him by saying that the woman had nursed him through a critical illness, and that his gratitude made him believe that he could find peace and contentment where an ordinary man would have known that nothing but disappointment and unhappiness would follow.

Realf himself said that he thought his mind was obscured at the time. After some years of misery he procured a divorce and remarried. Happiness seemed to be near again, but after two years, upon some technical grounds, the Superior Court reversed the decision of the lower court and declared his divorce illegal. Misfortunes then began to fall thick and fast. His second wife and children, for he had become the father of triplets, grew ill. Additional heavy drains were made upon his purse by a widowed sister and a paralytic brother, and to add to his cup of bitterness his first wife followed him to California and insisted upon claiming support. At last, bowed down and broken by misfortune, worry, and overwork, he ended with laudanum his eventful and unhappy life in the autumn of 1878. He made two attempts before success resulted, and between them composed the poem beginning "De mortuis nil nisi bonum," thus reminding us of Marcus Lucanus, "the eminent Roman poet of the silver age," who repeated lines from his poems descriptive of death as his life-blood ebbed away.

If we were to look carefully into the histories of the lives of men of genius, we should find many names to add to the number already mentioned, and still more to swell the list of those who had attempted the deed without meeting with success.

Haydon, the celebrated historical painter and writer, overcome by debt, disappointment, and ingratitude, laid down the brush with which he was at work upon his last great effort, Alfred and the Trial by Jury, wrote with a steady hand "Stretch me no longer upon this rough world," and then with a pistol-shot put an end to his unhappy existence.

Richard Payne Knight, the poet, Greek scholar, and antiquary, was a victim of melancholia, and finally destroyed himself with poison.

Burton, the vivacious author of The Anatomy of Melancholy, who had the reputation of being able to raise laughter in any company, however "mute and mopish," was in reality constitutionally depressed, and it is believed that he was at last so overcome by his malady that he ended his life in a fit of melancholy.

Kleist, poet and dramatist, brooded over suicide, attempted it once unsuccessfully, and finally, by agreement with Henriette Vogel, who believed herself affected with an incurable disease, repaired to a small inn near Potsdam, where they ended their lives together.

Lessmann, the humorous writer, like Burton, put an end to himself in a fit of melancholy.

Sir Samuel Romilly, a man of brilliant genius, by whose efforts the criminal laws of England were remodeled—a man loved for

his sweet nature and upright manliness—while overcome by grief at the death of his wife, with his own hand sought rest beyond.

Michael Angelo, after receiving a painful injury to his leg by falling from a scaffold while at work upon The Last Judgment, became so melancholy that he shut himself in his room, refused to see any one, and "resolved to let himself die." Fortunately, his intentions were frustrated by the celebrated physician Bacio Rontini, who learned by accident of his condition.

Vittoria Alfieri, of whom it has been said that every event in his life is either a factor of disease or a symptom of mental alienation, attempted suicide in Holland, while making one of his restless trips through Europe in search of change.

Kotzebue, who at last met a tragic death at the hand of an assassin, was at one time so melancholy that he meditated self-destruction. Happily, however, as he tells us, his habit of composition was so firmly fixed that he went on with his work and produced one of his finest dramas, Misanthropy and Repentance.

Cowper, as is well known, when bowed down by religious melancholy, made two unsuccessful attempts upon his life.

Chateaubriand, the brilliant representative of French literature, became so thoroughly discontented with himself and the world that he attempted to take his life.

Dupuytren, the distinguished anatomist and surgeon, whose kindly nature induced him to leave a large share of his fortune for the establishment of a benevolent institution for the relief of distressed medical men, contemplated suicide even when at the acme of his fame.

Cavour, "the regenerator of Italy," and one of the greatest of modern statesmen, twice attempted to kill himself.

Lincoln, as Herndon tells us in The True Story of a Great Life, was subject to fits of extreme melancholy. Nicolay also says that beneath his apparently cheerful and sunny nature there was an undercurrent of deep sadness. At one time, according to Herndon, his melancholy reached such proportions that his friends, "fearing a tragic termination, watched him closely day and night." At this time Lincoln himself wrote: "I am now the most miserable man living. To remain as I am is impossible. I must die, or be better, as it appears to me." While thus suffering he wrote and published a paper on suicide. But, to the glory of civilization, the shadows lifted, and he lived to place his name in perpetual honor by freeing the nation from "the incubus of slavery."

Lamartine, poet, statesman, and orator, when overcome by reverses which were as sudden as his successes had been, looked longingly toward the tomb.

George Sand declared that, whether it was that bile made her melancholy or that melancholy made her bilious, she had been frequently seized by a desire for eternal repose.

Goethe, who thought the suicide of the Emperor Otho worthy of praise, slept for several nights with a dagger under his pillow, trying to get up sufficient courage to imitate the act.

Comte, in a fit of depression, threw himself into the Seine; and there is abundant evidence that Shelley, whose unhappy life was clouded by the suicide of two women, himself contemplated the deed. Fanny Imlay's death by laudanum in the Swansea inn was followed in a few weeks by the recovery of Harriet Westerbrook's lifeless body from the Serpentine. The tragic death of Harriet was a frightful blow to Shelley, and there is no doubt that his character was altered by it. Thornton Hunt says, "I am well aware he had suffered sorely, and that he continued to be haunted by certain recollections which pursued him like an Orestes"; and Woodbury adds, "From that time a shadow fell upon him which never was removed." Whether it was the recollection of the watery grave of the woman he had wronged, or whether it was only the desire to rend the veil which hides the mysteries of the Great Beyond, it is certain that Shelley on more than one occasion contemplated self-destruction.

In Trelawney's interesting records of Shelley and Byron two striking instances are given. The first is a letter from Lerice, dated June 18, 1822, in which the poet writes: "You, of course, enter into society at Leghorn. Should you meet with any scientific person capable of preparing prussic acid, or essential oil of bitter almonds, I should regard it as a great kindness if you could procure me a small quantity. It requires the greatest caution in preparation and ought to be highly concentrated; I would give any price for this medicine. You remember we talked of it the other night, and we both expressed a wish to possess it. My wish was serious, and sprang from the desire of avoiding needless suffering. . . . I need not tell you," he adds, "that I have no intention of suicide at present, but I confess it would be a comfort to me to hold in my possession that golden key to the chamber of perpetual rest." Notwithstanding the denial that he contemplated suicide, an incident which happened soon afterward, and which is related by Trelawney in the same interesting chapter, leaves no doubt that Shelley more than once felt the suicidal impulse to an almost irresistible degree. To make free use of Trelawney's graphic words: "On a calm, sultry evening, while Jane (the wife of Shelley's friend Williams) was sitting on the sands before the villa on the margin of the sea with her two infants watching for her husband, Shelley came from the house dragging his skiff. After launching her, he said to Jane: 'The sand and

the air are hot; let us float on the cool, calm sea; there is room with careful stowage for us all in my barge.' She accepted the invitation, and, with the children, got into the boat. They soon drifted from the shore, and the poet, unconscious of her fears or of their danger, fell into a deep reverie, probably, as Trelawney suggests, reviewing all that he had gone through of suffering and wrong, with no present and no future. Jane spoke to him several times, but her remarks met with no response. "She saw death in his eyes." Suddenly he raised his head, his brow cleared, and his face brightened as with a bright thought, and he exclaimed joyfully, "Now let us together solve the great mystery." With a woman's instinct Jane knew that her only chance was to distract his thoughts, and, suppressing her terror and assuming her usual cheerful voice, she answered promptly: "No, thank you, not now. I should like my dinner first, and so would the children." This gross material answer to his sublime proposition so shocked the poet that he was brought back to himself, and paddled his cockle-shell boat into shallow water.

A deep melancholy pervades all of the poet's letters from Pisa and Leghorn, and it was at this time that he was engaged upon The Triumph of Life, which was left unfinished by his untimely end. The poem closes abruptly with these words: "Then what is life? I cried." A sentence of profound significance, as Mr. Symonds says, when we remember that the questioner was now about to seek its answer in the halls of death. With all this evidence before us that death was not unwelcome when it came on that fatal Monday in the winds and waves, is it not fair to assume that had it not come as it did a record of suicide would have been added to one of the most interesting as well as one of the most melancholy histories in the annals of English song?

The examples mentioned have been taken at random, and I am well aware that an exhaustive search would have made this paper many times as long. My only aim has been to cite a few prominent examples in illustration of a subject which to my mind is one of fascinating interest, and to draw, if possible, some deductions from them.

Evidence is not lacking to warrant the assumption that genius is a special morbid condition, and the anthropological school of which Lombroso is the brilliant master is daily gaining converts. Although the doctrines which he advocates have recently received a remarkable impetus, they are not essentially new. Centuries ago Seneca taught that there was no great genius without a tincture of madness, and Cicero spoke of the *furor poeticus*. It is also more than a hundred years since Diderot exclaimed: "Oh, how close the insane and men of genius touch! They are chained, or statues are raised to them." Lamartine speaks of the

mental disease called genius; Pascal says that extreme mind is akin to extreme madness; and everybody is familiar with Dryden's couplet:

> "Great wits are sure to madness near allied,
> And thin partitions do their bounds divide."

This is not a pleasant theory I will admit, but, as Lombroso says, does not the botanist find the same thing; and "has not Nature caused to grow from the same germs and on the same clod of earth the nettle and the jasmine, the aconite and the rose"?

But even though this view be not fully accepted, if we take into consideration the fact that the poet lives in an ideal world surrounded by creatures of his own imagination, to whom he attributes the most exaggerated sentiments, it seems to me reasonable to believe that sooner or later unhealthy introspection must be awakened and followed, not infrequently, by the development of morbid tendencies.

But, above all else, it is my belief that a lack of proper training in the early years of life was at the bottom of the unhappiness and mistakes in nearly all the cases mentioned. In the lives of Chatterton, Miller, Tannahill, and Realf, the ones which we have the most closely analyzed, we find a similarity of conditions truly remarkable. Each was born to poverty of the direst kind, each had but little systematic training, and each drifted about upon the sea of knowledge until stranded upon its shoals. If these unhappy lives teach us anything, they certainly show the necessity of guiding with the utmost care the physical, the moral, and the intellectual course of the erratic child of genius. The precocious child especially should receive our most careful attention, for there is more than a grain of truth in the old adage that "genius at five is madness at fifteen." I am myself convinced that precocity is quite as often an indication of morbidity as it is of genius. In rare instances it fulfills its promises, but it only does so when the overactive and unequally developed brain receives proper nourishment and judicious exercise. If the early training be wrong, disappointment is sure to result, and "the huddled knowledge," as Disraeli says, "like corn neglected in a well-stored granary, perishes in its own masses."

ACCORDING to Prof. W. M. Ramsay, a religious veneration, persistently attached to particular localities, has continued in Asia Minor through all changes in the dominant religion of the country. Modern Turkish survivals of old religious ideas constantly impress the traveler. They are apparent chiefly in the sanctity of particular spots. The sanctity is usually transferred from its original bearer to some Mohammedan or Turkish personage; or else there is a *dede*, or nameless heroic ancestor.

WILL THE COMING WOMAN LOSE HER HAIR?

By Miss E. F. ANDREWS.

I BELIEVE biologists are pretty well agreed that, if the present course of human evolution continues unchecked, the coming man is in serious danger of evolving into a bald-headed animal. What is to be the fate of the coming woman in this respect no one, as yet, has been bold enough to prophesy, though I think it may be safely assumed, for reasons presently to be given, that unless the æsthetic instincts of man should undergo a radical change, she will not only retain her "crowning" beauty unimpaired, but in augmented abundance and splendor.

Notwithstanding the gloomy predictions as to the "bald-headed and toothless future" (see Popular Science Monthly, October, 1886) in store for the human race, I have been more and more impressed, as the result of my own observations, with the almost complete immunity of my own sex from the results of those influences which are said to be operating so disastrously upon the personal attractiveness of the other. I have never seen a case of complete baldness among women of any age; partial baldness is rare, even among sexagenarians, while the large proportion of luxuriant suits of hair to be found among young women and girls would seem to indicate pretty clearly that, if baldness is to be a characteristic of the coming man, it will be one of those sexually limited variations, like hairy chins and guttural voices, that will not apply to the other sex.

It may be argued that the superior advantages possessed by women for concealing defects of this kind will prevent reliable observations being made in their case; but there are few women who do not know false hair from genuine when they see it, no matter how artistically arranged, and if any woman under sixty is afflicted with baldness it is pretty safe to assume that the other women of her acquaintance will know it. At all events, there are none of us, probably, who do not know the truth so far as our own mothers and grandmothers are concerned, and a simple comparison of their soft and often abundant gray tresses with the shiny pates of their spouses will be sufficient to convince most people that men, as a rule, have a practical monopoly of baldness.

And yet, most of the causes commonly assigned as conducive to this defect are as active among women as among men. They torture their hair with curling-irons and papers and hairpins to a degree that no man would tolerate for an instant; they deaden and discolor it with all kinds of injurious washes; they rear upon the top of their heads structures as heating and uncomfortable as a stovepipe hat, or hang upon the back of them appendages of such

size and weight as to strain every hair at the root, and produce continuous headaches; and while their headgear may not be of quite so preposterous a shape as man's, they wear it much more constantly, since they sit with their heads covered in all public places, while he as a rule wears his hat only out of doors. Then, too, women, as a general thing, enjoy much less vigorous health than men, eat less nourishing food—pickles and candy often constituting a large part of their diet—are more frequently sufferers from headaches, deficient circulation, general debility, and Heaven only knows what not; and yet, with all this, the sorriest specimens of the sex, physically, often luxuriate in the most abundant suits of hair.

Now, why should one sex enjoy such comparative immunity from the results of practices that are producing such disastrous effects upon the personal appearance of the other? The answer, I take it, is to be found in a cause which Mr. Darwin claims to have been the chief factor in all cases where the purely ornamental qualities of a species are concerned—sexual selection. While women, under the pressure of public sentiment against "old maids," and the more urgent pressure of material necessities, will, as a general thing, marry anybody they think likely to give them a support, regardless of personal defects or attractions, men are more fastidious, and it goes without saying that a bald-headed woman would stand little chance, to use Mr. Darwin's argument, of leaving offspring to inherit her deficiencies. I have never known a woman who would make a bald head an invincible objection to a man who was eligible in other respects. Most of them are indifferent to that peculiarity, while some even like it; they think it looks intellectual, as more than one young woman, unsuspicious of the grave scientific motive underlying my frivolous "chaff," has assured me.

After occupying myself for some time with observations upon old and middle-aged people, it occurred to me that the influence of this subtle factor, sexual selection, could best be determined by observations upon boys and girls under twenty, in whom, it is to be presumed, the influences of heredity have not yet been supplemented, to any great extent, by other causes. Accordingly, I had printed, and sent out to teachers and school superintendents, five hundred blanks, calling for statistics on the subject, with the request that they be filled and returned to me within the year. Of the five hundred, eighty-six were returned, and some of these contain discrepancies that render them practically worthless—a result, be it remarked in passing, which betrays a curious indifference on the part of teachers to matters of biological interest. The Atlantic City schools are the only ones from which I succeeded in obtaining anything like a full report, my efforts being ably

seconded by their energetic and wide-awake superintendent, Major W. F. Slaton.

Now, while the statistics at my disposal are too meager to warrant any definite conclusion, it is nevertheless a significant fact that out of a total of 1,196 males between the ages of ten and twenty, ten cases were reported as showing signs of baldness—that is, ·0084, or over eight tenths of one per cent—while in a total of 1,374 females of the same age, but one single case is reported, or about ·00073, a little over $\frac{1}{100}$ of one per cent. In other words, if the unsatisfactory statistics that I have been able to collect can be relied on, the proportion of baldness in boys and girls under twenty is about 80 to 7. As the majority of girls at the age under consideration wear their hair loose, or in simple "Marguerite" braids, so that there is little likelihood of deception, while unwholesome headgear or other individual practices can hardly, as yet, have had time to produce any material effect upon either sex, we may regard the differences indicated by the figures as practically due to the working of heredity alone. Now, there is no apparent reason why girls should not inherit a tendency to baldness as well as boys, unless that tendency is checked by some other factor. Such a factor is sexual selection; for I presume it is hardly necessary to argue here that a bald-headed woman would not stand much chance of "survival" in the struggle for matrimonial honors. As men have always practically done the "selecting," and will probably continue to do so more and more as the conditions of modern life render the competition for husbands more severe, the woman's voice in the matter, when she has any, being limited to a simple negative, it is not likely that the state of baldness to which the human race is said to be tending will ever affect the feminine half of it. There are compensations in all things; and while the individual woman may sometimes murmur at the hard law of dependence which forces her too often to find in some measly little specimen of masculine humanity her only refuge from starvation, the sex in general has to thank the fastidiousness which their superior position cultivates in men for its exemption from a defect as destructive of beauty as of comfort. The time is, perhaps, not very far distant when, in the course of human evolution, a man with hair on his head will be as great an anomaly as a bearded woman, but as long as men love beauty and are won by personal charms, so long will women continue to rejoice in those abundant tresses of brown and gold that are one of the chief ornaments of their sex.

THE PROBLEMS OF ANTHROPOLOGY.*

By RUDOLPH VIRCHOW.

INTERNATIONAL prehistoric congresses have for a whole generation exercised a great influence upon the researches and the ideas of our contemporaries. This institution was founded at the time when the discoveries of Boucher de Perthes of the existence of man in the Drift period; the observations of Ferdinand Keller on pile constructions; those of Cristi and Lartet on the troglodytes of the Dordogne, and of Vorso on the kitchen-middens; and the theory of Darwin and his disciples, were producing a revolution in scientific traditions. As a result of that revolution, the Congress found itself confronting a great problem. It was incumbent on it to study all the countries of Europe in order to collect prehistorical traces of man, to attract general attention to the origin and course of human civilization; and it proposed to itself to remove the veil of mystery from before the primitive cradle of man.

Many of the questions which were raised at this time have now been definitively resolved. We know that man existed in the Quaternary epoch, that he lived through long ages miserable and depressed, while stone, wood, horn, and bone constituted the material of his arms and of his only instruments; we are convinced that a long interval separated the age of stone from the age of metals, and that only in particular places was the use of stone immediately replaced by that of metals. These are the data which now make part of the general knowledge acquired by civilized nations since the foundation of the Congress. But further studies respecting the origin and the regions whence the different branches of civilization have sprung have advanced relatively but very little.

First, the question of Tertiary man especially occupied the Congress, and reached its culminating point at the meeting in Lisbon. We were taken there to the plain of Otta to look in the strata for his remains. We found there flint chips that might in an extreme case be regarded as having been cut by man; but we discovered no human bones or potteries or worked objects; and the majority of the Congress, on leaving the place, were far from being convinced that these flint chips were distinguished, in any respect, from the *débris* which is found in the ground everywhere, and which results from the disintegration of a siliceous soil. Nobody has ever found in virgin Tertiary strata any piece of flint that has been recognized by the learned world as an unquestionable relic of the ex-

* Address at the opening of the International Congress of Prehistoric Archæology and Anthropology, at Moscow.

istence of man. We have likewise reached the same result in our search for human skulls and bones. We have to recognize that students can not assume that man existed in the Tertiary, or that there is any probability that the human race had its beginning in that epoch; on the contrary, we find a great void which we try to fill with fantastic imaginings, but which furnishes us with no real specimen.

After the Congress of Lisbon, students were more moderate and confined themselves to the search for known objects. Among these objects, archæological finds predominated, and it is easy to understand why archæology has more and more taken the place of anthropology. Palæanthropological objects are so rare, and for the most part so liable to suspicion, that even till the present time the attempt to describe the most ancient race of Quaternary men is beyond the power of science. We have had two examples in Europe that afforded little encouragement: the attempts based on the Canstadt and on the Neanderthal skulls, which, as two eminent students once supposed, belonged to the extinct aborigines of the primitive European race. We discussed the question raised over these two skulls fifteen years ago, at the Congress of German Anthropologists in Ulm, and found that the Canstadt skull did not belong to the Quaternary, while the Neanderthal skull was at least very far from having a typical form.

I shall not examine the whole series of similar discoveries, most of which have only furnished us single exceptional skulls. But I must declare that even if these skulls had been what they were described as being and their geological position had been exactly defined, they could not have constituted proof of the existence of an inferior primitive race that could be regarded as a step between animals and existing man. Many of these skulls appear to be very ancient; but they resemble in all respects the skulls of modern races, and some of them even those of civilized races. We seek in vain for the "missing link" connecting man with the monkey or any other animal species.

We must, however, understand ourselves on a preliminary question. There exists a tradition common to all peoples, or we might say a dogma common to all religions, recognized by all students, ancient and modern, that the human body has an animal organization; that the same physiological and pathological laws rule human and animal life alike. Notwithstanding this uniformity, there exists a definite barrier separating man from the animal, which has not yet been effaced—heredity, which transmits to children the faculties of their parents. We have never seen a monkey bring a man into the world, nor a man produce a monkey. All men having a simian appearance are simply pathological variants. The opinion of Carl Vogt that microcephalous men,

resembling simian animals, are produced by atavism, has been wholly abandoned since students have reached the conviction that the skulls of microcephals have indexes of pathological formation, with deficiencies arising from degeneracy.

The human organism, especially in the embryonic stage, is distinguished by many features that have been borrowed, not from the monkey only, but also from other animals. The living elements, the cells, present us the same types in man as in the mammals; sometimes these resemblances in the embryo continue to exist, and are even developed after birth. But this persistence or hyperplasy can not be made to serve as proof of the animal origin of man. Let us take this example of a hyperplasy of this kind: there is in the higher anthropoid apes a bony ramification that connects the jugular of the temporal with the frontal bone. It is sometimes developed in man, and is wanting in some individuals among the higher monkeys. I have shown, and M. Anoutchine has confirmed it, that this ramification occurs very frequently in the Australians, and we both regard the peculiarity as of simian origin. But we can not conclude from that that the Australians are simian-like, for the same peculiarity has been remarked, in some infrequent cases, in the skulls of Europeans; while there is not an example of men having such heads having furnished any other indication of simian organization or development. The bony ramification of the temporal jugular is nothing else than a special peculiarity, sometimes individual, sometimes racial, like curly hair, for example. When we look at a negro's head we might say that it resembles a sheep or a poodle; but, so far as we know, nobody has yet expressed the opinion that negroes are descended from sheep or from dogs. Still, the negroes are like sheep and poodle dogs in the hereditary transmission of a special peculiarity in their hair. In spite of that, their heads in no way resemble those of the animals we have mentioned. Bearing in mind these observations, we have become more circumspect now in our reasonings upon individual or racial analogies between man and animals; we certainly shall not forget that the human organization is in its essentials an animal organism, and that the monstrosities which occasionally appear may be regarded as results of atavism; but we shall require more convincing arguments before we assume a near relationship of man with any definite animal.

It was generally believed a few years ago that there yet existed a few human races which still remained in the primitive inferior condition of their organization. But all these races have been objects of minute investigation, and we know that they have an organization like ours, often indeed superior to that of supposed higher races; thus, the Eskimo head and the head of the Tierra del Fue-

gians belong to the perfected types. Some races have the same skulls very small, of about the same volume as the microcephalous skulls; for example, the inhabitants of the Andaman Islands and the Veddahs of Ceylon have been regarded as microcephalic. A more exact study has, however, shown a difference between them and the real microcephalic races. The head of an Andaman-islander or of a Veddah is very regular, only all its parts are a little smaller than among men of the ordinary races. Nanicephalic heads (dwarf), as I call them, have none of those characteristic anomalies that distinguish really microcephalic heads.

A single race, that of the Orang-Simaings and the Orang-Cekai of the peninsula of Malacca, still remains unstudied. The single traveler who has penetrated into the mountainous countries inhabited by them, the bold Russian, Miklukho Maklai, has ascertained that certain isolated individuals among Simaings are small and have curled hair. A new expedition has been sent into that country to study the anthropology of the Orang-Cekai, from which I have recently received a skull and a few locks of hair; the stock is really a black race with curly hair, the brachycephalous head of which is distinguished by very moderate interior volume, but it does not offer the most trifling sign of bestial development.

Thus we are repulsed at every line of the assault upon the human question. All the researches undertaken with the aim of finding continuity in progressive development have been without result. There exists no *proanthropos,* no man-monkey, and the "connecting link" remains a phantom.

Scientific anthropology begins with living races; and the first step in the construction of the doctrine of transformism will be the explanation of the way the human races have been formed, and of the means by which they have acquired their specific peculiarities while still preserving hereditary transmission. That is the future field of anthropological debate and investigation. But this field is outside of the limitations of our Congress. It is easy at first sight to suppose a dolichocephalous skull to be transformed into a brachycephalous skull, but still nobody has ever observed the transformation of a dolichocephalous race into a brachycephalous one, or *vice versa,* or of a negro race into an Aryan race.

Prehistoric anthropology should find methods of facilitating acquaintance with the types of ancient races and peoples, and of making possible the discovery of them among living men. It might add to that, if the occasion should present itself, data respecting strange individual cases, by the aid of which it is impossible to form a continuous line or constitute a genealogical tree, but which should be kept in the scientific lumber-room till

the time when we can find the intermediate links that may unite them into a series.

And now let us continue faithful to the glorious traditions which our great masters have bequeathed to us. The majority of the students whose names are inscribed in the preceding congresses were archæologists. Lartet and Dessort, Vorso and Liche, Hozedine and Clericci, Ouvarov and Romer, who remain the protecting genius of our congress, have shown us how we must work. To select an example, questions like that of the discovery of copper, and of its value as a medium of exchange, ought to be problems of the greatest interest to us.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE ROTATION OF THE FARM.

By APPLETON MORGAN.

IT was an English maxim, as old as Harold, and it is probably a safe one to-day, that "horses feel a famine first." The meaning, of course, is that, in the commencement of a dearth of cereals, the stables would be pillaged of the grains fed to the horses by a hungry populace before it clamored to the authorities for bread.

They seem to have changed all that in Massachusetts. There lies before me a pamphlet, issued by the authority of the Commonwealth of Massachusetts, entitled A Descriptive Catalogue of Farms in Massachusetts, Abandoned or partially Abandoned (issued under the provisions of chapter 280 of the Acts of 1891), by William R. Sessions, Secretary of the State Board of Agriculture, November, 1891. Certainly this is a startling head-line, and those of us who had begun to have faith in modern methods, in agricultural colleges, in the chemistry of crop rotation, by which the element exhausted by the yield of one year should be supplied by the next, confronted by it might begin to weaken as to the compensations, and what had been supposed to be the eternal laws of reciprocal affinities! Is it possible, we would perhaps find ourselves asking, that the Massachusetts farmer, the nearest in the Union in point of mileage to the two or three greatest of its markets, should "abandon" the fields of his ancestors? That, after generations of tillage, any tracts of agricultural land anywhere are diverted to other utilities in the course of their prime function of supporting life is a familiar contingency. Lands once agricultural may be covered by residences or factories as neighboring towns spread out to include them. But absolute abandonment would seem the rarest of possibilities, so long, at least, as

the United States is relied upon, as it is to-day, for its over-proportion of the food of this planet of ours. Almost three fifths of the grains, fully half of the meat supply—not to mention the cotton yield—of the civilized world, are expected to be forthcoming from this direction, and yet the New England farmer proposes to "abandon" his share in this great field—a field wherein the farmer, as a farmer, has practically no competition to meet at all! A great deal is being said about the surrender of the farmer class to the appetite for other pursuits. But really it is not, or ought not to be, as bad as that. If other things are equal, as they should be, and if all the adjustments are true, as they should be, there should always be a farmer class and always farms. And while the New England farmer suffers from the American failing of making farms too large, equally with his far Western brother, yet his offset is that, unlike the Western farmer, he does not suffer from immoderate or too numerous middlemen (handlers or brokers), but has, or can have, his market at his door.

The horses in Massachusetts have never yet raised the alarm of famine—not even in the days of the Embargo, or in the cruel times of 1812–'16, when the noble old Bay State was forced by her patriotism not only to send soldiers into a war of which she did not approve, but to see her own peculiar industries ruined, and the only ones ruined, while the war for which she was supplying bone and sinew stimulated every rival industry in her sister States: a pelican situation, which, bad as it was, did not dishearten her or make her falter in her duty. But even then the Massachusetts farmer, who paid a dollar for his hoe, sixty cents a yard for his calico, and thirteen cents for a nutmeg (not a wooden one from a sister State), did not "abandon" his farm. The horses then or since have not been heard from. Why, then, should the State in its paternal capacity step in, announce that her farmers had abandoned her farms, and offer them for sale to strangers? And, so far as the stranger is concerned, he might well ask why he should be expected to buy that which is advertised as useless. One can not exactly break up a farm, as one breaks up a ship, and sell it for junk. At what point, one might ask, does the interest of the stranger directly accrue? Again, there are so many ways of utilizing one's farm. It can be a stock farm, a grazing farm, a dairy, a fruit, a market garden, a poultry, a seeding, a nursery farm. Salt hay is cut from marshes. Cranberries grow in bogs; and if one could not raise cranberries, how about frogs? There is always a demand for the esculent hind legs of those interesting amphibians in some seaboard city; and, indeed, our political economy will not listen to any such thing as a failure in demand or supply of luxuries, however bizarre, any more than of necessities in their due proportions. It is related that even in the

midst of the Reign of Terror many of the gentle born, who could not escape from the bloody French cities, hid in garrets or other penetralia, and kept body and soul together by making lace or decorating fans or tapestry; for there was always, it seemed, somebody to buy the yield of fripperies. As long as anything can be produced upon them there should be no abandonment of farms in the vicinity of markets.

We might note, too, that this curious phenomenon of "abandoned" farms in Massachusetts is seen to be further complicated by the fact that it occurs—if it occurs at all—in the face of the extraordinary efforts of that noble State for the educational, the agricultural-educational, betterment of her sons in her agricultural colleges. And, still more suggestively, it appears to the reader of this pamphlet that the Massachusetts farms now "abandoned," or sought to be abandoned, are actually nearer to natural markets or to adequate markets for their produce than any better lands, however served by competing railroads, can possibly be. Nor do I think that the cheap "long haul" which might be supposed to bring the Western prairie into competition with the New England farm will be found to have that effect. The haul is too long and not cheap enough to make the large difference necessary to any such theory. Statistics need not be quoted, surely, to show that the great cities of the Atlantic debouch some thousands untold of their population for at least a third—for certainly a quarter—of the year, into the vicinity of these very markets; or that the great transoceanic facilities—the huge steamships with their abridged transits which have made Europe into a sort of American watering place—have worked no appreciable difference in the mass of Eastern city life which, for that third or quarter of the year, summers in these New England States, and certainly does not draw its consumption of food from any other than these New England markets. Those great laws of compensation (quite as little capable of formulation perhaps as they are perfectly constant and understood) may be relied upon to provide at least this much, to wit, that the increased facilities for visiting Europe from our large trading cities would themselves enrich a non-Europe-visiting class sufficiently to enable it to itself seek a nearer vacation at home, in New England itself, let us say, and so offset the class which, with increasing wealth, yearly finds itself able to cross the Atlantic for its annual outing.

Why, then, in the teeth of this very law of compensating economy, in the teeth of applied science, and in the teeth of the constant rules of supply and demand, should farms in New England be or seek to become "abandoned"?

I believe that certain statistical societies find the reason in what they call sometimes "overeducation," and again sometimes

"sentimental education," and yet again "classical education"—the vast numbers of public schools in which not only are all branches of learning taught, but the text-books for teaching them supplied at the public expense (we are confining ourselves to the New England States); the enormous diffusion of cheap literature, or of good literature at cheap prices; the great preponderance of fiction over other reading matter—all these, they tell us, surely and unerringly tend to depopulate farms and to render farm life distasteful to those who live upon them. The farmer's daughter is unwilling to rise early to milk the cows; the farmer's son does not care to fodder the cattle or drive them to the plow or to the harvesting. The daughter has read higher things and prefers her piano, and the son has heard of opportunities of amassing wealth galore in the cities, and every Sunday newspaper tells him of what others have done and of what, therefore, it is assumed that he can do in amassing equal wealth in their streets. This sort of thing is rehashed until it has become a literature in itself, and need not be more than referred to here. But is this the real reason after all? There used to be a proposition quite equally relied upon by these very statistical societies (though I have not heard much of it lately) which ought to counterbalance or compensate for this tendency of the rural youth to cities. It used to be said, I believe, that the cessation of a certain branch of any given industry released a certain proportion of power, which turned itself to some other; for example, that the loss by a city like Portland of its India sugar trade, or by New Bedford or by Sag Harbor of its whaling interests, would be no loss to the community at large, because the handlers of sugar or of whales would gravitate to other employments, and so the economical balance of the community be preserved. If this principle still obtained, then—in view of the large creation of entirely new industries within the last ten or twenty years, such as, for example, the electric power and light, the telephone, the typewriter, the clipper of newspapers (the last three of which certainly do not discriminate in favor of the stronger sex; or, if they discriminate at all, might be said to discriminate against it)—this principle of mutual release ought to be still to the fore; but somehow or other it is not as familiarly quoted now as it was once. I have, for example, heard it gravely argued by a gentleman in New York city, who writes much and well upon economical and politico-economical questions, and who is an enthusiastic free-trader, that, if the doctrine of protection was carried far enough to create new industries in the United States, those industries would require the building of great mills and factories; and that, while those factories were being built, the time of thousands of working people would be on their hands, and that the loss of wages incurred by some thou-

sands of employees who were waiting for those factories and mills to be built would be a serious item in the national wealth! Most of us would not be kept awake of nights by the fear of decreasing national wealth, I think, from that particular state of affairs! Some labor, no doubt, would be required to build those same mills and factories. The laborers who were to build them would perhaps be drawn from somewhere, and so leave vacancies to be filled from somewhere else. But the prospect as it seems was enough to seriously alarm this gentleman; and I doubt not that, from a standpoint the reverse of his, it might still have its terrors to even less special and specious theorists, who still cling to the old fallacy that figures always tell the truth, and will not hear of the proposition of the Irish gentleman in Christie-Murray's delightful novel, who called figures the biggest liars in existence! Because, then, the farmer's daughter prefers her piano to her milking stool, and her brother his bicycle to his fodder scythe: or—let us say, because the one would rather sell ribbons and the other foot up columns of figures in city establishments than to continue in the duties which a residence upon the ancestral acres imposes —the whims or caprices of a few boys and girls are creating great gaps in the agricultural precincts which the supreme, even if elusive, laws of economical compensation are unable to fill!

It would seem to be a rather violent proposition this: namely, that one's personal whim can explode or dominate the laws of supply and demand.

Instead of the rotation of crops, is it not what might be called the "rotation of the farm," brought on by the exchange of farm for city employments by a constant or periodic ratio, which has called for the Massachusetts pamphlet?

The man who lives in the country yearns for the city. The man who lives in the city yearns for the country. The farmer would seek pent precincts of the town and bend over ledgers; the clerk, already bent double over his ledgers, craves the free air and the unconfined horizons of the farm, the distant hills, and the broad acres between. Variety, is it not, which they both seek? In opposite currents, doubtless, but both continually by immutable tendencies. Such is certainly the optimistic theory of the situation implied by these "abandoned" farm pamphlets. Is it the true one?

To assume that the farmer will farm no more would be a fearful prospect for our race—quite as fearful as to assume that the soldier would not fight for his country against any other country, that the tailor would not make us clothes, or that the shoemaker would not supply us with shoes. Surely it would be great gain, not only to the Commonwealth of Massachusetts but to the national commonwealth, if, instead of drawing grewsome and doleful mor-

als from a pamphlet with the pathetic title, Catalogue of Abandoned farms in Massachusetts (or New Hampshire or Vermont), we could infer that the issuing of these catalogues was but a rational and normal detail by way of facility in the progression of that great law which moves communities of individuals back and forward, and back and forward again, from one precinct to another, and from one vicinage to another on the map of societies and of States, but always conserving and preserving the equation of prosperity, of tranquillity, and of the general content in and between and around them all.

Taking the Massachusetts pamphlet as exemplary of them all, it seems to me that the above is the fact. For I find, first, that this abandonment amounts rather to a desire to sell at some fair or "lump" price (and I may add always one somehow approximate to the general value of the land, which certainly is not even as a figure of speech an "abandonment"); secondly, I find that the "abandonment" is larger the farther we leave the seacoast and traverse toward the interior countries. The pamphlet shows that 3·45 per cent of the total farm average of the State now offered for sale lies outside of the limits of cities, in the extreme interior, while only about 0·87 per cent of such farm land is situated toward the seacoast.

In Nantucket and Suffolk Counties—the one an island and the other a peninsular county open on three sides to the seacoast—no such "abandoned" land is offered for sale at all. In Essex County, adjoining Suffolk, where the interior nature of the territory is a trifle larger than in Suffolk, we have a return of salable land under this pressure, of a trifle less than 0·06 per cent. In Hampshire County, where several settlements are to this day without railroad or telegraphic facilities, containing perhaps but a single town of any size, and where intercommunication is about as rare as an eclipse of the sun, the percentage of land offered for sale is the highest, being 6·85 per cent; thus clearly proving, if figures can prove anything, that it is the desire for community, the weariness of isolation, the craving for society, rather than a seeking for the precariousness of new employments, or a failure of the land he has tilled so long, which leads the ruralist to woo forced markets for his farm lands and new industries elsewhere for himself. And not only is this the case, but in a study of this very pamphlet there appears the confirmation of this proposition that normal forces and attractions invariably find their counter-forces and attractions. It appears that as soon as the Massachusetts authorities announced their purpose of issuing this list of "abandoned farms," inquiries concerning these farms were received in considerable numbers. These the Bureau of Agriculture carefully tabulated to the States whence they came,

with the following results: England (London), 1; Canada (Montreal), 2; Washington, D. C., 1: Texas, 1; Illinois, 2; Michigan, 3; Montana, 1; Ohio, 2; Florida, 3; North Carolina, 1; Virginia, 4; Washington Territory, 1; Pennsylvania, 5; California, 1; Iowa, 1; Connecticut, 10; New Hampshire, 4; Vermont, 1; Rhode Island, 9; New York city, 79; Massachusetts coastwise counties, 140.

It certainly seems to me that there could be no clearer proof than this that the desire to move inland comes from the thickly populated coast lines and the vicinities of the larger cities. That, after all, the greatest demand for Massachusetts farms comes from Massachusetts itself must be a glory and a pride to that noble old Commonwealth, and an acquittal from the charge that her thousands of common schools and hundreds of town libraries have cultivated in her sons and daughters a distaste for the life of an independent farmer. It is not abandonment, but rotation, and seems to illustrate one of Emerson's postulates, viz., that "demand and supply run into every invisible and unnamed province of whim and passion." But, apart from whim and passion, there is a great justice in this rotation. The catalogue might have been entitled A List of Farms in Massachusetts whose Owners are willing to sell them rather cheaply, and better express what actually appears to be the situation. The Rotation of the Farm, or the Rotation of the Owner of the Farm, would seem to be the better title.

Mr. Francis Galton avows himself a qualified believer in the possibility of signaling to Mars. Accepting as a fact that the Lick telescope can bring the planet optically to within 50,000 miles, he has found that a reflected beam of sunlight, sent through a hole one tenth of an inch square, is visible as a glint at a distance of ten miles. Hence, with fairly clear atmospheres, the flash from many mirrors simultaneously, whose aggregate width is fifteen yards and their aggregate length, say, to allow for slope, twenty-five yards, would be visible in Mars, if seen through a telescope such as that at the Lick Observatory. "With funds and goodwill there seems no insuperable difficulty in flashing from a very much larger surface than the above, and sending signals that the inhabitants of Mars, if they have eyes, wits, and fairly good telescopes, would speculate on and wish to answer. One, two, three, might be slowly flashed over and over again from us to them, and possibly in some years, to allow time for speculation in Mars to bear fruit, one, two, three might come back in response."

The remarkable pit of the Creux de Souci, France, is situated in a sheet of recent basalt on the south side of the Puy de Montchal. The opening is eighty-two feet in diameter and thirty-eight feet deep; but at that depth a hole about ten feet wide communicates with a hollow seventy feet deep, at the bottom of which is a stagnant pool overladen with carbonic acid which forbids access to the water surface. The interior is a vast vaulted hollow, apparently formed in the basalt when semi-fluid, by an explosion of volcanic gas. The temperature falls from 51° Fahr. in the open air to 34° near the water.

THE LOGIC OF ORGANIC EVOLUTION.

By FRANK CRAMER.

IN his work on the Principles of Science, Jevons described with great clearness the logical phases of scientific theories and illustrated them by a wealth of instances drawn from the sciences of mathematics, physics, astronomy, and chemistry. While he accords to the theory of evolution an importance equal to that of any other theory, he says but little about its evidence or logical history. He practically leaves the biological sciences and geology untouched, except in the chapter on classification, where he says, in closing the subject: "Natural classification in the animal and vegetable kingdoms is a special problem, and . . . the particular methods and difficulties to which it gives rise are not those common to all cases of classification, as so many physicists have supposed. Genealogical resemblances are only a special case of resemblances in general."*

The sciences of chemistry, physics, and astronomy, based as they are on mathematics, allow precise statement and accurate experiment. In geology and biology, on the other hand, the factors are so complex that these sciences take on the nature of historical sciences, with all the difficulties which such a statement implies. The difference can be easily illustrated. Certain perturbations of the planets indicated the presence of another one as yet unseen. The amount of the disturbances could be accurately determined. Adams and Le Verrier almost simultaneously predicted the presence of Neptune at a definite point in the heavens, and the prediction was verified by the immediate discovery of the planet. The human race must have appeared at a definite time in some definite part of the earth; but biological science lacks all the factors with which to parallel the case of Neptune by pointing out by a prediction the time and place of the appearance of the race. It knows that the event occurred, but must wait for accident to reveal the place and depend on the broadest generalizations to reveal even the relative age of man.

The utter lack of rigidity in the relations of living things puts quantitative statement almost entirely out of question; except that in some cases it is possible to work out a valuable system of averages. Individual beings can be measured, but the laws of biology can not be put in mathematical form; hence the lack of mathematical precision, without which the history of a science does not lend itself very easily to logical treatment. Evolution is pre-eminently a historical law, but its relations to the evidence

* Jevons, Principles of Science, p. 727.

for and against it are such that its logical history is both unique and inspiring. If it has passed through a definite series of logical phases similar to those through which the mathematico-physical sciences have passed, if it has fulfilled the same conditions and led to similar and equally brilliant results, its logical status is permanently fixed.

The cell doctrine,* which now lies at the foundation of biological science, illustrates an important principle in the growth of theories. The significant points in its history, for the present purpose, are: 1. It took its earliest shape as a botanical theory, arising from a very small part of the facts that it was destined to explain. 2. Those facts were the most obtrusive of the whole group of facts to which they belong. The most highly wrought products of the forces involved are always first discovered, and thus it comes about that the facts which are most difficult to explain and which are farthest away from the point where Nature began its work, at first form the foundation of a scientific theory. Knowledge increases by traveling backward from the specialized to the generalized, and the theory is perfected only after a complete series of facts has been secured in this way.

One of the results of this principle is that all scientific doctrines in which a historical arrangement of phenomena is involved must pass through what is aptly called the catastrophic stage. The geological doctrine current in the early part of the century, that there have been successive world-wide catastrophes followed by recreations, was perfectly natural in that stage of the science. Only the most obtrusive facts were known. The mountains were regarded as simple products instead of very complex accumulations of the effects of forces working steadily. When geology passed from catastrophe to continuity, it made its great permanent stride forward by providing itself with a key to all the facts that have since been discovered.

The theory of evolution has passed through all these developmental stages. The law itself was not recognized until long after formal relationships had been established, and its discovery was simply a recognition of the principle of continuity. Natural history began with species—the mountain-ranges of biology—and regarded them as simple facts instead of last terms in a long series. The breaches between species, as between mountains, was what made them striking. The evidence that has been destroyed played an important part in the early stages of this as of all other lines of scientific reasoning which are dependent on historical evidence. The more hidden and comparatively insignificant facts, the residuum which constitutes the difficulties of classification,

* Sachs, History of Botany.

here as everywhere, compelled recognition by forcing themselves in increasing numbers upon the attention of biologists. The effort to suppress them by the old theory gave place gradually to the effort to base the new idea of continuity upon them. This period of reversal in scientific activity and the accompanying rapid reinterpretation of both the old and new phenomena, while it is recognizable in the histories of many sciences, is probably most striking in the history of evolution.

Every hypothesis by its nature accords with the facts from which it sprang. But it is the weakness of all hypotheses, true and false alike, that they are at first based on only a small part of the facts, and these are nearly always the most unsafe, because they are, as has been shown, the most highly specialized. The true hypothesis has to pass successfully through the ordeal of assimilating large bodies of facts that are already known by observation apart from the hypothesis. The theory of evolution did this as thoroughly and perhaps more rapidly since Darwin's time than any other scientific theory. There is a vast number of illustrations of this, but a typical one will suffice. Anatomy had long ago established the presence of valves in human veins, and physiology assigned to them the only intelligible function—that of preventing the blood from flowing back toward the capillaries. Had they been distributed throughout the venous system, there would have been no problem; but they are present in some veins and absent in others. No law regulating their distribution could be assigned, and students of human anatomy had to learn their distribution by sheer force of memory. Here was a fine group of arbitrary facts established by empirical observation. Not only was there no law to explain their distribution—their actual arrangement was utterly irrational if it were true that they were intended to prevent the backward flow of blood. It was easy enough to understand, from the old view of creation, why there should be valves in the veins of the arms and legs; but it was stultifying to learn that the spinal, iliac, portal, and above all the inferior vena cava, the largest vein in the body carrying blood upward, are without valves. To make the facts and their functional explanation still more incongruous, there are valves in the intercostal veins, in which the blood flows horizontally; and in the thyroid and internal and external jugulars, in which the blood flows down hill. Valves and gravitation apparently had nothing to do with each other.

Dr. Clevenger* was the first to explain this group of facts by an application of the theory of evolution. If the theory is true,

* Physiology and Psychology, Clevenger, pp. 38–46. American Naturalist, January, 1884.

man's ancestors were quadrupeds, and the time during which he has walked upright is insignificant compared with the time during which they walked on all fours. The structures developed in his ancestors and not yet modified to suit his new posture should be expected to hold anomalous relations. So far as known, the general distribution of valves in the veins is the same in man as in the mammals near him, and when he is placed back on all fours the arrangement of the valves is perfectly intelligible. The veins of the limbs, the jugular and intercostal veins, then carry blood upward; and the venæ cavæ and other valveless veins are horizontal and have no need of valves. Many important facts of a pathological nature are accounted for by the theory of imperfect adjustment of bodily structure and posture.* This explanation of them is so striking that Clevenger irreverently suggests that the original sin of man may have been the act of getting up on his hind legs.†

When a theory has thus assimilated all the groups of facts related to those from which it sprang and which are unintelligible without it, it has fulfilled the philosophical requirements of a true theory. But every great generalization opens more problems than it closes. This has been true in astronomy, physics, chemistry, and geology, and is true of biology. There are now numberless questions to be answered in biology which could not even be raised without the theory of descent. An illustration may be drawn from the case already cited. Some of the cephalic veins have no valves, but should have them if the explanation is true; the azygos vein has rudimentary valves, but does not need them in the quadrupedal state. These facts become new problems and require subsidiary explanations. By regarding some of the imperfect valves as obsolescent and others as nascent, some disappearing because they are no longer useful and others appearing where they are needed, the exceptions are mostly removed. Frequently such exceptions are not simply accounted for under the theory, but form some of its most striking proofs.‡ Fruitfulness in furnishing problems for solution, instead of indicating weakness, proves the strength of a theory. Alchemy, the Ptolemaic astronomy, and the doctrine of special creation alike, could not lead to a thousandth part of the scientific activity that has followed in the wake of the theories that supplanted them, because they furnished no way of approach to the numberless special problems.

The irresistible power of a true theory rests in the end in the

---

* Piles, prolapsus uteri, inguinal hernia, etc. † Trout of Yellowstone Park.

‡ For a fine illustration see Wallace, Geographical Distribution of Animals, vol. i, pp. 209–214.

possibility which it opens of asking and answering questions by the deductive method. It might be supposed that a theory without a mathematical basis would exhibit comparatively little power of prediction, although its validity might never be questioned. Quantity of effect can not be measured, much less predicted, by deduction from theories susceptible only of historical treatment. All that can be expected is the power to indicate the presence or absence of things that are still unknown. But the laws of heredity, variation, correlation, etc., although still undefined and perhaps undefinable, furnish peculiar opportunities for brilliant deduction.

Paleontology would be a sorry science without the power of restoration afforded by the principle of correlation. Its fragments of bones and teeth and stumps and leaves would be almost absolutely worthless. But from the standpoint of logic this is as truly prediction by deduction from known laws as the minute predictions for the nautical almanac. Perfect heredity would place the principle on a basis of certainty. Any one character of ruminants indicated to Cuvier the presence of all the rest. But the generalized types of paleontology are transitional forms possessing combinations of ruminant characters, with others belonging to the carnivora, such as he never dreamed of. But the recognition of secular change in the correlations of organs, instead of weakening, has strengthened the possibility of anticipating unknown facts.

In recent years the progress from deduction to verification has been so rapid that frequently the latter has followed at the heels of the former, so that the element of time has hardly entered between them to make them both more striking. Many of the deductions from the theory of descent, afterward verified, are commonplaces to the scientist, but their logical force is not sufficiently emphasized when the nature of the evidence is considered.

The doctrine of descent required the belief that ruminants once had upper incisors and canines. The belief was made almost a certainty by the presence of partially developed fœtal teeth where they are absent after birth. The confident expectation was justified by the discovery of generalized ruminants with full sets of teeth. If man were descended from lower forms, an explanation was required for the absence of the os centrale as an independent bone from the human wrist, for it is almost constantly present in amphibians, reptiles, and mammals. Rosenberg looked for it in the human embryo and found it. Wiedersheim * was moved to declare that this was one of the greatest triumphs that morphology, based on the theory of descent, had yet won. The

* Wiedersheim, Lehrbuch der vergleichenden Anatomie der Wirbelthiere, p. 223.

same logical process was exemplified in the discovery of abdominal ribs in the human embryo.

As long ago as 1801 Blumenbach inferred from the configuration of its skull that ornithorhyncus laid eggs, and his deduction, based on the known correlation of characters, was verified by Caldwell's recent demonstration that the monotremes are egg-layers. There was an unverified deduction that monotremes must at some time have possessed normal teeth; it was verified by the recent discovery of calcified teeth in monotreme embryos. "Thatcher showed in 1887 that fins of fishes are derived from two pairs of lateral folds. In a paper on the significance of bone structure Dwight commented on this and said that if evolution were true he could see no reason why no vertebrate had more than four limbs. He also said that he could see no reason why no vertebrate had more than two eyes. In the same year Watase demonstrated that the Japanese goldfish has eight limbs and Spencer showed that all vertebrates have a third eye in the pineal gland. Spencer predicted that fossils would be found in which the pineal eye was functional; Cope demonstrated in fossils the orbit of this third eye and pointed out the attachment of muscles for its movement." *

"Evolution suggested the annelids as remote ancestors of the vertebrates. Kowalevsky was thus led to the discovery of germ-layers among these animals—homologous with those of vertebrates. In the same way, but on the other side, Semper was led to the discovery of genuine worm kidneys (*nephridia*) in the lower fishes. Starting with the theory of genetic affinity, we have discovered a whole series of organs and tissues that had hitherto remained unknown. For example, we have now the 'spinal ganglia' in worms, the 'spinal nerves,' and, what is perhaps more important, we have discovered the sense organs out of which the sense organs of the vertebrates have been gradually built up." †

One of the best-defined anticipations, and one that found confident expression from different sources, in the way of special predictions, long before it was verified, was the belief that primitive mammals were generalized types. Cope wrote, March, 1874, "I trust that I have made it sufficiently obvious that the primitive genera of this division of mammals (*Mammalia educabilia*) must have been bunodonts with pentadactyl plantigrade feet." ‡ "No perissodactyl or artiodactyl mammal was known at that time to possess such feet, nor was any perissodactyl known to possess tubercular teeth." Since the prediction was made, Cope has described nine species of the Eocene genus *Phenacodus*, "prob-

* Kingsley. † Whitman.

‡ Journal of Academy of Natural Sciences, Philadelphia, March, 1874.

ably the most generalized mammal known." They had five toes on each foot and a bunodont dentition; with primitive ungulate characters went complete sets of unmodified teeth and foot bones.*

Marsh's famous pedigree of the horse illustrates the same process. Both he and others clearly foresaw many of the results that he afterward worked out. A large part of the logical value of this restoration of the genealogy of the horse family arises from the fact that what is now established by investigation was once an unverified deduction.†

Such verifications, especially in paleontology, are often due to accident. The predictions might, therefore, and often actually do remain unverified and practically unverifiable, because it is not known where to look for the evidence. Such unverified deductions are frequently scouted as absolutely worthless for the purposes of biological science. This attitude is not taken toward similar deductions in other sciences, for the single reason that there are no external reasons for combating the theories. Enumerating a number of such cases from physics and chemistry, Jevons adds, "To my mind, some of the most interesting truths in the whole range of science are those which have not been, and in many cases probably never can be, verified by trial."‡

The most famous of these unverified deductions in biology is that concerning the descent of man. The facts on which the deduction that man is descended from lower animals is based are derived from anatomy and embryology. The evidence is circumstantial; but one of the most brilliant of the predictions enumerated was based on this deduction and verified by embryology. It is only with respect to the paleontological evidence that the "deduction is unverified." But if the chain of missing links were absolutely complete, it would only be circumstantial evidence. The direct evidence is forever beyond reach, because when the race was born there was no scientist present to observe it.

This case serves well to illustrate the nature of the objections to the theory. The best theory of evidence of a historical nature has been worked out by the law courts. There, no amount of negative evidence has any value whatever in the face of even circumstantial evidence of a positive nature. The only way in which the accused one can shake off the implication is, to furnish positive evidence that some one else committed the crime, or that he was in some other definite place when it was committed. A careful consideration of the well-understood doctrine of *alibi*,

---

* Cope, American Naturalist, August, 1884.

† Marsh, American Journal of Science, March, 1874, and other papers in the same journal.

‡ Principles of Science, p. 548.

which involves all negative evidence, might have prevented a generation of logical inconsequence in the discussion of man's origin. The fact that no so-called connecting links have been found can have no value whatever as evidence until it is shown that the whole earth has been searched and that there are none, and that no such fossils have ever been destroyed by natural processes. The deduction is justified by the evidence from other departments.

Agassiz, I believe, made the promise to furnish the positive evidence that no such fossils ever existed by showing that the geological series, at least so far as man is concerned, is complete; and hence that if they ever existed they should have been found. Death interfered with the fulfillment of the promise. He, like others, believed that man appeared at some definite place at some definite time in the world's history. Had he succeeded in proving the geological series complete, he would have caught, not others, but himself, in his logical toils. He first of all men would have been under obligation to show when and where man did appear, and that connecting links were not among the circumstances that immediately preceded his appearance.

The radical disappearance of objections to the theory before the introduction of new and especially the pertinacity of the old evidence is extremely interesting. There are imperfections in the evidence, many of which can never be removed. But the difficulties are not logical but practical; they are due to scientific ignorance. In every phase of its development the theory has fulfilled the conditions imposed upon it by logic, and repeated the history of other established scientific doctrines. At first superficial and catastrophic, but approaching through formality to Nature's path, biological science finally entered upon an explanation of its natural arrangements and formal laws. The theory of evolution itself passed from the condition of a simple induction to the explanation of vast numbers of facts that had been empirically discovered; opened new fields of investigation; led to the discovery of whole series of phenomena that had been previously overlooked; and gave rise to confident expectation frequently culminating in definite predictions subsequently verified by investigation—until, in the words of perhaps the foremost investigator in America, "we are in fact doing hardly anything else to-day than to verify the suggestions which evolution makes."*

* Whitman.

PROFITS OF LEGITIMATE BUSINESS NOT TOO LARGE.

By P. F. HALLOCK.

IN The Popular Science Monthly for November Mr. J. B. Mann discussed the question, "Are Business Profits too Large?" His article is a defense of those business methods which have made the Vanderbilts, the Stewarts, and the Goulds. It is our purpose to briefly examine the statements from which he draws his conclusion.

That labor is at a great disadvantage is admitted, but Mr. Mann says, "It is a disadvantage imposed by Nature, and so need not be discussed." If this were true, there would be greater need of discussion, but fortunately it is not. Nature provides bountifully for all—there is a surplus of everything, and no one is required to be a drudge; but, by following the "gospel of greed," a few have taken possession of the wealth produced by the many, and amid an abundance half our people are fighting for a bare living. The ability to legally take from the masses justifies the taking, in the opinion of Mr. Mann. This is the new version of that barbarous rule of conduct, "Might makes right." A commercial pirate is worse than the one who robs by force, for the former is protected in his robbery. No man, by honest methods, can make millions in a few years. Such a one must, in some way, accumulate without rendering an equivalent. There is no principle of economics clearer than this.

To show that the workingmen get their full share of what they produce, Mr. Mann states that "there is no business of recognized legitimacy that pays labor only a third. . . . There is no business that gives to capital and skill combined even ten dollars out of thirty." If these sentences mean anything, it is that labor gets more than two thirds of production. This is not true of the following industries: The manufacture of iron and steel, the mining of coal, the manufacture of boots and shoes, the manufacture of sewing machines, the petroleum industry as carried on by the Standard Oil Company, the lumber business, the manufacture of clothing, watches, matches, and salt, not to mention the numberless notions that are consumed in every household. The truth is that the actual labor cost of almost every staple is a small fraction of its selling price.

Mr. Mann says that only one in ten has a competency by his own exertions, and that one because he was energetic, faithful, competent, and thoroughly systematic from the start. Before the era of paternalism this was the rule, now it is almost an exception. There are at least a hundred men in the city of Pittsburg who have been more industrious, more economical, and who are

fully as skillful as Mr. Carnegie, and yet are not worth ten thousand dollars apiece. How did it happen? They had to depend upon their own resources, while the Government gave Mr. Carnegie the power to tax every consumer of iron and steel. Another set of men are rich because they taxed the consumers of sugar, another made their millions by the duty on glass, another built railroads at the expense of the nation, and another swindled corporate stockholders and robbed the people generally. Yet, in the face of these facts, Mr. Mann would have us believe that great wealth is the product of honest industry and consummate skill, and that the millionaires are our real benefactors.

The way in which the middlemen and the railroad kings help the farmer is cleverly illustrated by Mr. Mann; but the farmer, he adds, is so unreasonable as to find fault with them, simply because they have made more money than he has. In other words, the farmers' complaints arise from envy—they have no real grievance.

A superficial knowledge of human nature, without being acquainted with the facts in the case, would discredit the statement. Men do not seriously complain without a reason; a person making a thousand dollars a year is not envious because a neighbor makes two or three thousand. The village merchant who by fair dealing has accumulated twenty or fifty thousand dollars is not hated by his customers and townsmen. The possessor of a legitimate fortune is invariably respected. Let us now turn to the facts. In 1860 there were practically no tenant farmers in the country, now twenty-five per cent are renters. Before the war, the farmers owned seventy per cent of the wealth of the nation; in 1890 they owned thirty-five per cent, and paid sixty-five per cent of the taxes. More than thirty per cent of the farms are mortgaged, and the average rate of interest will exceed eight per cent.

When the farmer could no longer be blinded by political prejudice, he realized his condition and forthwith discovered that, while he had been paying the taxes and growing poorer and poorer, another class had been growing richer and richer; they were few in numbers but all-powerful; they not only controlled the business of the country, but the legislation; they were the real rulers of the republic. Is it any wonder, then, that the farmers complain, that they have organized for protection? That they have been so slow to move in their own behalf and so conservative is certainly surprising.

Mr. Mann somewhat rashly assumes that the rich pay their portion of the taxes, and that their wealth would not be in existence had they not produced it. It is generally conceded that the rich do not pay their just share of the public burdens. All eco-

nomic writers admit this, and I never heard it questioned before. Under the present system of taxation taxes are shifted from the landlord to the tenant, from the creditor to the debtor, from the manufacturer to the consumer, from the corporations to their patrons—in a word, from capital to labor.

The second proposition, that the rich create their wealth, is equally untenable. Manipulation and production are totally different. No person can add to the actual wealth of the nation, unless he be an inventor, a million dollars; it is beyond the power of production; but by manipulation, by donations, and by legislation, men may possess millions, but they never created them. Instead of the rich adding to the nation's wealth they take from it, by depriving the producers of the capital which they need to make their work effective; there is a limited amount of money, and when concentrated in the hands of a few the real workers are at a disadvantage, and the amount of wealth produced by them is perceptibly lessened. This applies to the farmers, to most manufacturers, and to business men generally.

Neither in the statement of the question nor in the argument is there a distinction made between business men. The tradesman who with difficulty keeps from insolvency, or actually fails, is classed by Mr. Mann with the Stewarts and the Vanderbilts. No one complains of the great body of business men. As a rule, their profits are not too large. They would make more money if the farmers and the wage-earners were prosperous. Those who are responsible for all the complaints, for all the injustice, for agricultural depression, are the seventy-five thousand who own more than half the wealth of the country, and whose wealth is due to class legislation, to a vicious system of taxation, to national and State donations, to swindling the people through the agency of corporations and limited partnerships, and to gambling in securities and the necessaries of life.

Lieutenant Peary reports as results of his Arctic Expedition, that he determined the northern coast of Greenland and found the ice cape ending south of Victoria Inlet; and that he reached, at 34° west longitude, the latitude 82° north. This is the highest latitude ever reached on the east coast of Greenland, and has been exceeded in all the annals of arctic exploration only by the attainment by Lieutenant Lockwood, of Greely's expedition, of 83° 20′ on the west coast.

According to an address by the Rev. C. J. Ball at the recent International Oriental Congress, the vocabulary and the grammar of the ancient language of China are now being traced back to the yet more ancient speech of the early civilizers of Babylonia. The identity of the two systems of writing is established by detailed comparisons of selected characters; of Chinese terms referred to Accadian originals; of numerals and pronouns; and of features of syntactical arrangement.

TOTEMISM IN THE EVOLUTION OF THEOLOGY.*

By Mrs. CLARA KEMPTON BARNUM.

THE thoughtful student of universal history can plainly see, under the clear light afforded by modern research, that the line of continuity from the lowest savagery, to the highest civilization is unbroken; the vast interval between the two extremes being filled by "the series of advances through which the marvelous and complicated mechanism of refined societies has issued from the savage condition in which the first men long lived."

Anthropologists study closely the myths, customs, and traditions of uncivilized tribes of our own time, as they are thought to present the most reliable ideas of ancient peoples when they were in a similar stage of mental development.

This method commends itself to that large class of cultured minds, trained in the doctrine of evolution, who believe that, in examining things present, they have data from which to reason in regard to what has been; there being no necessity for imagining other causes than those now in action to account for the past in either the physical or psychical world.

The savage regards all Nature as a combination of distinct intelligent personalities. He draws no line of separation between himself and material things, but thinks every object upon which his eyes rest is endowed with life akin to his own. He even believes that the sky, wind, sun, and dawn are persons, "with human parts and passions." He looks upon the lower animals as more powerful than himself, and therefore worships many of them as divine and creative. This crude *personalism* has well been termed the distinctive philosophy of primitive culture.

Totem is a word introduced into our literature by an Indian interpreter of the last century, but it is only within recent years that totemism has been studied scientifically. It prevails almost universally among the aborigines of Australia at the present time. It is also found among savage tribes in North and South America, as well as among peoples in the same primitive stage of culture all over the world. The totem is never an isolated object like a fetich, but always a class, such as species of plants or animals—usually the latter—which certain stocks of men worship, and from whom they consider themselves descended. The clans take the name of their animal deity, such as Wolf, Bear, Serpent, Raven, and Fox. The stock name is generally traced through the female line, and no man is allowed to marry a woman who has descended from the same animal ancestor.

---

* Suggested by reading A Washington Bible Class, by Gail Hamilton.

There are many conclusive reasons for believing that all ancient races, during their early development, lived under this crude system, and, like the savage stocks of our own time, based their laws, both social and religious, upon the well-marked lines of totemism.

The figures of the gods in ancient Egypt were represented on the monuments for ages in animal form. The organization of the local population ran on totem lines. Each city had different beast gods. In the royal genealogies, beasts are named as ancestors; showing that the early Egyptians actually considered themselves descendants of animals. The primitive element in the early Greek religion has been preserved in the "sacred chapters," fragments of which have been given us by Herodotus, Pausanias, and others—proving that the oldest images of the Grecian gods were represented in animal forms, and that the different royal houses claimed descent from animals, as do the savages of America and Australia. Mr. J. McLennan, in his papers on The Worship of Plants and Animals, calls our attention to many evidences that the early Romans as well as the Greeks worshiped totems. The Old Testament records show—notwithstanding the various revisions through which these venerated books have passed—many indications of animal-worship among the Israelites, which must have lasted for ages before the prohibition inculcated in the second line of the Decalogue was formulated. At a comparatively late date "Jehovah was worshiped under the popular symbol of a bull, while the twelve oxen upholding the laver in Solomon's temple, as well as the horns adorning the altar, were drawn from the prevalent bull-worship."* Modern research has also proved that the cherubim were represented in the form of winged bulls. M. Lenormant, in his famous book on the Beginnings of History, says that, during the time of the kings and prophets, "most assuredly the cherubim, as there described, are animals."

The process by which the anthropomorphic god superseded the worship of the totem deity has been suggested by Mr. Andrew Lang. "The encyclopædia of myths," as he has been rightly called, has gained the lasting gratitude of all earnest students of primitive culture for his lucid explanations of the puzzling problem of animal-worship. He says: "Among certain peoples, as in Samoa, we see the process of advance toward the Greek and Syrian view of sacred animals. They allege that, in these various beast-totems of their various stocks, the one god common to all these stocks is *incarnate*. . . . Savage ideas like these would account for the holy animals of different deities, especially in

* Wrong and Right Uses of the Bible. By Rev. H. R. Newton.

Greece, where each god has a small menagerie of sacred animals; and it seems probable that these animals were originally the totems of the different stocks subsumed into the worship of the anthropomorphic deity."

In Egypt, when animal-worship became associated with anthropomorphic conceptions, the figures of the gods after the twelfth dynasty exhibit a gradual transition by being represented in a mixed figure of an animal's head upon a human form.

Apis, the sacred bull, was worshiped from the earliest period, but does not appear on the monuments until the fourth dynasty. Apis was supposed to have been born from a virgin cow rendered pregnant by a moonbeam, or a flash of lightning. We find in the theology of an African tribe the story of one of their gods being born in a similar mysterious way from a cow; and we see a survival of this savage thought in regard to Indra recorded in the Rig-Veda: "His mother: a cow, bore Indra, an unlicked calf." The mother of Apis shares on the monuments the honors of the bull, and is represented, under the attributes of Isis Hathor, as a goddess with a cow's head. The hieroglyphics represent Osiris adorned with horns, or with the head of a bull, and unite the two names, Apis-Osiris. According to Greek tradition, Apis was the *incarnation* of Osiris.*

Careful study proves to us that "the peculiar mark of the wilder American tribe legends is the bestial character of the divine beings, which is also illustrated in Australia and Africa, while the bestial clothing, feathers or fur, drops but slowly off Indra, Zeus, Dionysus, the Egyptian Osiris, and the Scandinavian Odin."

In following the slow advance in culture from animal-worship to the highest monotheistic conception, we are forced to admit that "*all* religions are one and the same religion, in various stages of evolution, taking on different colors from local soils and climates, and thus developing many varieties." In the earliest phases of religious development we find the idea of two beings, one good and the other evil, who are supposed to be engaged in constant warfare. This widely spread dualistic myth seems to have originated in the primitive mind through an attempt to explain the origin of evil in the world. Men ask in Australia, as in Persia, "Why do things go wrong?" and are answered by the myth—still surviving in modern theology—of the evil one who has thwarted the Creator of all things. Among the Thlinkuts, on our Western continent, the great opponent of their totem deity—the Raven—is the wicked Wolf, the ancestor of the wolf race of men. In certain Australian tribes their creative totem—the Eagle Hawk—is always at war with the evil crow.

---

* Article Apis, by Dr. Samuel Birch. Encyclopædia Britannica, ninth edition.

While among savage tribes the evil being is represented by different members of the animal kingdom, in nearly all mythologies of civilized peoples the evil power is depicted in the form of a gigantic serpent. Indra—in the form of a bull—fights the demon serpent Vitria. In Persia the same idea is represented in the evil Ahriman, in his continual warfare with the good Ormuzd. In Egypt, it was Osiris and Typhon; in Scandinavia, Odin and Loki; and in Judaism, Jehovah and Satan.

The necessity of a third being to mediate between the two opposing powers seems the natural outgrowth of this dualistic conception, producing the *triad*. It is worthy of note that the idea so prominent in savage theology—immaculate conception—remains imbedded in the mythology of civilized races, the third member of the triads being always represented as virgin-born. In Egypt, Horus, the son of the virgin goddess Isis, overcomes the power of the evil Typhon. Zoroasterism retained for a long period the dualistic conception, finally added to the two antagonistic powers, Mithras as the Savior and Mediator. In India it was Vishnu, who took upon himself the form of a man, and became known as the Restorer.

The same impulse which forced men to rise from the disconnected fancies of animal-worship, compelled a further advance to the adoration of one God. This monotheistic element is seen running through the theological conceptions of savage and civilized peoples, in their worship of one supreme God presiding over a number of inferior deities. Even in polytheistic Rome there can be framed from the leading Roman authors an almost complete system of monotheism; while it is well known that, from the time of Anaxagoras (500 B. C.), the great philosophers of Greece were virtually monotheists. The conception of one God was accepted by the Israelites through the spiritual teachings of the great prophets, a few centuries before the Christian era; yet modern scholarship has proved beyond all doubt that this belief "was the evolution there of a germ implanted in the human mind everywhere." When the gentle Prophet of Nazareth—aided by that energetic philosopher Paul—had freed the Hebrew God from the narrow limit of nationality, and portrayed the Soul of the Universe as the loving All-Father, who is a spirit and should be worshiped in spirit and in truth, the highest monotheistic conception was given to the world.

The striking likeness exhibited in sacrificial ceremonies among all ancient peoples proves that they can be traced to one type of society common to primitive man, and that form, according to the highest scholarship, is based upon the system of totem stocks. The animal worshiped as a totem is never eaten by members of the clan excepting upon occasions of expiatory sacrifices, although

among those clans who have what is called a split totem—that is, parts of animals—only a special part is forbidden as food. Dr. Robertson Smith, who has given us so many evidences of totemism among the Semites, says, "In totemism, and in no other system, laws of forbidden food have a direct religious interpretation, and form the principal criterion by which the members of one stock and religion are marked off from all the others." Colonel Garrick Mallery, in his highly suggestive address, before the Association for the Advancement of Science, on the Israelite and Indian, assures us that "the survival of totemism may be inferred from the lists of forbidden food in Leviticus, xi, and Deuteronomy, xiv. It would appear that, at about the time of the Exodus, the Israelites were organized upon the basis of families or clans, tracing through female lines, and named Hezir (swine), Achbor (mouse), Aiah (kite), Arod (wild ass), Shapan (coney), and so on.

Each of the clans refrained from eating the totem animal, or only ate it sacramentally. As the totemic organization declined, the origin would be lost, but the custom lasted, and when the legislation was codified it was incorporated in the code.*

The primary meaning of *sacrifice* is food offered to the gods, for they were supposed to partake of the gifts of food. In Greece originally each clan had its own gods, which were real totem ancestors. Apollo Lycius had his statue in wolf form at the Lyceum, and, at this god's sanctuary in Sicyon, "legend preserves the memory of the time when flesh was actually set forth for the wolves, as totem-worshipers habitually set forth food for their sacred animals." Prof. Smith states that even the highest antique religions show by unmistakable signs that in their origin sacrifices were literally "the food of the gods."

In Israel the conception, against which the author of the fiftieth Psalm protests so strongly, was never eliminated from the priestly ritual in which the sacrifices are called "food of the deity" (Leviticus, xxi).† The idea of a relation between the god and an individual was never grasped by primitive peoples, but they thought the relation existed between the deities and some social group, such as a tribe, clan, or nation. This peculiar method of thought gave rise to the belief that in any offense committed by one member of the tribe all were equally guilty; consequently, when any calamity came upon them it was an evidence that some sin had been committed that must be expiated. This childish fancy developed into atoning sacrifices, the primordial germ of which is found in the worship of totem deities. It is evident that human sacrifices predominated in early times, but as people be-

---

* See Popular Science Monthly for November and December, 1889.

† See article Sacrifices, Encyclopædia Britannica, ninth edition.

came less savage the horrors of the ritual were modified by the substitution of animals.

Among totem-worshipers the substitute for the life of a member of the tribe was naturally an animal of the kind which the devotees and god claim as kindred. Among our Indian worshipers of totems the sacred animal is eaten, *body and blood*, once a year, in a solemn sacrifice of *itself unto itself* in a mystical ceremony. These gross rites are thought to have an atoning efficacy, as they claim that the sacred animal shares the nature of their god, who in this manner dies for his people, while at the same time the life of the sacred beast passes into the lives of the communicants and unites them to their deity and each other in lasting bonds. These savages believe, however, that the sacrificed deity is made alive again; just as in Athens, when the sacred bull was slaughtered, the mystic ritual asserts that "the dead was raised in the same sacrifice."

We find strict attention to form and ritual among all primitive peoples, and the more cruel and mysterious the rites the lower the mental plane of the devotees.

That the religious forms called *mysteries*, of Egyptians, Persians, Greeks, and other ancient nations, evolved from the crude mysteries of their savage ancestors, is the firm conviction of our most profound scholars. In the celebration of these mysteries, which were enacted all over the ancient world, it is found that "the doctrine of a future life, connected with the legend of some hero or deity, who had died and descended into the under world, and again risen to life, dramatically represented in the personal experience of the initiate, was the heart of every one of the secret religious societies of antiquity.*

The Egyptian mysteries were devoted to the worship of their supreme god Osiris, whose name we find very near the beginning of what is known of the religion of Egypt. The early form of the legend shows its savage origin. In the constant warfare between Osiris and Typhon, the evil overcomes the good, and Osiris is killed, but afterward returns to life in the form of an animal, and urges his son to avenge him. Horus and Typhon fight in animal form, and the evil one's power is destroyed, but Typhon is not annihilated. As the Egyptian religion lasted for at least five thousand years, it was subjected to innumerable influences, which modified somewhat this crude legend. In time the worship of Osiris spread from Abydos, the oldest royal seat, all over Egypt, until all the religious mysteries and the whole doctrine of life after death attached themselves to the Osirian worship, where every year was enacted with many sad rites the

* Alger, History and Doctrine of a Future Life.

death of Osiris, ending with joyful ceremonies, celebrating the resurrection.

We are assured that the Grecian mysteries originated from the same animistic plane as those of the mystic ritual of Egypt. Even Plutarch admitted that the myths of Dionysus, Apollo, and Demeter, "all the things that are shrouded in mystic ceremonies and are presented in rites," are just as absurd as the legend of Osiris and Typhon.

The mysteries of Dionysus originated in ancient Phrygia, and passed into Greece in early times. Archæologists state that it is impossible to fix a date for the beginning of this kingdom, as it appears to have risen on an older civilization. It was a Greek tradition that the Phrygians were the oldest people, and their language the original speech of mankind. Zabazius was the original name of Dionysus in Phrygia, and his earliest images were of wood, with the branches attached. Later he was represented in the form of a bull with a human head; and when the anthropomorphic stage was reached his image was in human form, sometimes adorned with the horns of a bull. He had many sacred animals, but the bull was the one particularly connected with his worship.

The reproductive forces of Nature being dramatically portrayed in these mystic ceremonies, and the symbols given in forms which would explain their meaning to all beholders, it naturally follows that the method upon which these signs were based might be pure or obscene, according to the mental development of the people by whom they were given. Tradition shows that the latter predominated in the rites of that which has been termed Nature-worship. The class who have made a careful study of this subject state that there is not one of the ancient religions—the Israelite *not* excepted—which has not deified the sexual relation by some ceremonial rite connected with the solemn service of religion. It is evident that these forms evolved from such savage customs, as is still witnessed amid the orgies of the serpent-worshipers in Africa.* The peculiar custom of circumcision is thought to have originated in these gross symbols, as a sacrifice to the deity supposed to rule over the reproductive forces, as well as being also a substitute for human sacrifices. After the Phrygian mysteries were introduced into Greece, Sabazius was known under the name of Dionysus, or Bacchus, the god of the vine, whose functions were similar to those of the Vedic god Soma. Here Bacchus was called the son of Zeus and Demeter, and his birth, death, and resurrection were dramatically represented in the Grecian mysteries. Out of the combined rites connected with

* See Vudu Worship, by Major Ellis, in The Popular Science Monthly, 1891.

the worship of Bacchus, Apollo, and Demeter evolved the famous and widely popular Eleusinian mysteries. These religious ceremonies are thought by those who have made a study of early Greek life to have been instituted about the time of the first record of the Olympian games—776 B. C.—but the final molding of this elaborate ritual was not completed before the sixth century B. C. "The mysteries of Eleusis were the one great attempt of the Grecian genius to construct a religion that would keep pace with the growth of thought and civilization." The survival of savage thought in these rites, the progressive spirit of this cultured age, attempted to overcome, while trying at the same time to preserve, their fervor and self-devotion. There were four successive stages in the ceremonies connected with the celebration of the Eleusinian mysteries—confession, purification through immersion in water, the initiatory rites, followed by the last and crowning one, when the communicants were admitted to the most holy place and partook of the flesh of Demeter, or Circe, and drank the blood of Bacchus—this rite taking the place among these people of the holy sacrament in the Christian Church. We find many evidences from the Greek authors of that period that the people who joined this religious assembly were thought to lead better lives, and that through this connection *salvation* after death was assured them. Sopater asserted that "the initiation establishes a kinship with the divine nature." Plato wrote: "He that has been initiated has learned that which will insure his happiness hereafter." Plutarch, in a letter to his wife, wrote: "Some say the soul will be entirely insensible after death, but you are too well acquainted with the doctrine delivered in the mysteries of Bacchus and with the symbols of our fraternity to harbor such a thought." Thomas Taylor has given us these lines from an old Orphic hymn:

> "The soul that uninitiated dies,
> Plunged in the blackest mire of hades lies."

Modern research has proved that the celebration of the Eucharist, in the mysteries of all ancient peoples, was considered by them as their highest act of worship and the most solemn ordinance of their religion. In the Egyptian mysteries the communicants partook of bread which had been consecrated by their priests, and was then regarded as the veritable body of Osiris, just as in ancient Mexico the worshipers of the supreme Mexican god ate sacramentally paste images made of corn and blood, after a sacred formula was pronounced over the symbols. The devotees informed the Spaniards who witnessed these ceremonies that they were partaking of the body and blood of their god. When the Mithraic mysteries were introduced into Rome, and were celebrated in the world's metropolis, the holy sacrament

of bread and wine was a prominent feature in the worship of Mithras.

"There is a remarkable syncretist painting in a non-Christian catacomb in which the elements of the Greek mysteries of Demeter are blended with those of Sabazius and Mithra, in a way which shows that the worship was blended also." The most important rite of all these antique mysteries being the Eucharist, led the celebrated Cicero to exclaim, "Can a man be so stupid as to imagine that which he eats to be a god?" It has required a great effort for intelligent minds in all ages to reconcile their imaginations to the bloody ritual so prominent in all religious ceremonies from the earliest age. It is a relief to refined and spiritual natures to be able to look down the long ages of time and see that the early rite from which each evolved was instituted by savage peoples, and celebrated in their ignorant worship of animals.

It is a self-evident truth that "*the ideas which the religious instinct has once grasped it seldom abandons*"—consequently there are countless survivals along the entire line of religious progress, of beliefs and customs belonging to lower planes of culture, which have been, as far as possible, adapted to higher systems by giving them new names or more spiritual explanations. To this cause must be ascribed the fact—so evident to all students of comparative theology—of the early Christian Church becoming incrusted with the rituals and religious customs of the pagan world. The late Dr. Hatch, in the Hibbert Lectures of 1888, demonstrated, in the most convincing manner, "the influence of Greek ideas and usages upon the Christian Church." Every thoughtful person who has made even a slight study of this all-important subject is compelled to unite with him in saying: "Greece lives—not only its dying life in the lecture-rooms of universities, but also with a more vigorous growth in the Christian churches. It lives there, not by virtue of the survival within them of this or that fragment of ancient teaching, and this or that fragment of an ancient usage, but by the continuance in them of great modes and phases of thought, of great drifts and tendencies, of large assumptions. . . . No sooner is any new impulse given, either to philosophy or religion, than there arises a class of men who copy the form without the substance, and *try to make the echo of the past sound like the voice of the present.* So it has been with Christianity. It came into the educated world in the simple dress of a prophet of righteousness. It won that world by the stern reality of its life, by the subtile bonds of its brotherhood, by its divine message of consolation and hope. Around it thronged the race of eloquent talkers, who persuaded it to change its dress and to assimilate its language to their own. It seemed thereby to win a speedier and completer victory. But it purchased conquest

at the price of reality." Rev. Dr. Hatch not only proves that a majority of the rites of the Grecian mysteries have been transported into the Christian Church, but he also solemnly asserts that the peculiar tendency of the Greek mind to speculate, define, and dogmatize led to the establishment of the orthodox faith. The original meaning of dogmas are "*simply personal convictions*," and, while the statement of one man's convictions may be accepted by other men, still they never can be quite positive that they fully grasp the meaning of the original framer. "The belief that metaphysical theology is more than this, is the chief bequest of Greece to religious thought, and it has been a *damnosa hereditas*. It has given to later Christianity that part of it which is doomed to perish, but which yet, while it lives, holds the key to the prison-house of many souls."

SKETCH OF LEWIS MORRIS RUTHERFURD.

AN article by M. L. Niesten, published in the thirty-ninth volume of the Monthly, showed how greatly science is indebted to amateur astronomers; that about half of the living astronomers whose work had gained a footing in science were amateurs; that many of the most important discoveries in the heavens had been made by them; and further, that "other laborers than astronomers have assisted in the advance of the science by furnishing amateurs easier means of examining the sky and bringing the greatest exactness into their observations." An eminent demonstration of the truth of M. Niesten's remark, and of the value of the assistance which an amateur has been able to render astronomy in both sides of the work as described by him, is afforded by the subject of this sketch. Educated for the legal profession, and having begun his career in it, he gave it up for the more favored pursuit of astronomical observation; perfected instruments; and performed the most essential part in introducing and establishing the photographic method under which the most rapid advances in the science are now made.

LEWIS MORRIS RUTHERFURD was born at Morrisania, N. Y., November 25, 1816, and died at his country home, Tranquillity, N. J., May 30, 1892. He could trace a Scottish ancestry on his father's side through seven hundred years. His grandfather, John Rutherfurd, was a nephew of our Revolutionary major-general William Alexander, or Lord Stirling, and was United States Senator from New Jersey from 1791 to 1798. His mother was a direct descendant of Lewis Morris, one of the signers of the Declaration of Independence. He entered the sophomore class of Williams

College when fifteen years old, and was graduated from that institution in 1834. Having studied law with William H. Seward in Auburn, he was admitted to the bar in 1837, and practiced with John Jay, and after his death with Hamilton Fish. His tastes, however, drew him toward the physical sciences. While in college, he had yielded to them, and became assistant to the Professors of Chemistry and Metaphysics in preparing their class lectures, and had made pieces of apparatus with his own hands for them; and having found the scattered parts of an old telescope in the lumber-room of the college laboratory, he had reconstructed the missing pieces and put the whole in order. His own means, to which was afterward added the fortune brought by his wife, made the transition from a life of professional work to one of travel and study and amateur experiment an easy one. During a residence of several years in Europe, he studied optics under Prof. Amici, a famous adept in that science, and acquired knowledge which he was destined to put to most fruitful use in after-years.

After his return home he built upon the lawn of his home at Eleventh Street and Second Avenue, New York, an observatory which has been called the finest and best-equipped private astronomical observatory in the country. It had a transit instrument, and a refracting telescope with an object-glass eleven and a half inches in diameter, made by Fitz, with a second glass for photographing, corrected by his own new methods and finished by himself; the seeing lens, when photographs were to be taken, being unscrewed from the tube and the photographing lens being put in its place. A similar instrument was constructed under his direction for Dr. Gould and taken by him to the Argentine Republic, where it is still in use, a portion that was broken during the voyage having been replaced under Mr. Rutherfurd's directions.

For use in his own observatory, in place of this instrument, Mr. Rutherfurd made with his own hands an equatorial telescope having an object-glass of thirteen inches aperture. In order to employ it for photography without being compelled to take out the seeing object-glass, he constructed a third lens, which, being placed outside of the ordinary object-glass, converted the telescope into a photographing instrument. The visual focus of this telescope was of fifteen feet two inches distance, and its photographic focus of thirteen feet. In this construction he took account of the effect of temperature on the length of the galvanized iron tube. He devised and constructed a measuring machine for measuring the star-plates, arranged to determine the position-angle and distance of every star on a plate from a central star; and with this had measures made on many of the star-plates, among them the

Pleiades and Praesepe clusters. The measuring machine was improved in 1868 by using a glass scale, one division of which was equal to ten revolutions of the micrometer screw. Mr. Rutherfurd continued his photographic work for twenty years, or till 1877, after which year no photographs were taken by him. "Mr. Rutherfurd," says Prof. Gould, "was the originator and the introducer of the photographic method of observation. To him is due the first idea and employment of an object-glass constructed for employing the chemical rays rather than the visual ones; as also, later, that of the 'photographic corrector' for adapting an ordinary object-glass to its best use in securing sharp definition of the stars upon the sensitive plate. He personally planned the construction of the first instruments of these classes, prescribed the curves for the several surfaces of the lenses, and superintended the preparation of the object-glasses, which were made, with the assistance of Mr. Zitz's son, in his own house, by methods devised and made practical by himself alone. So, too, was it he who introduced the precautions by which the sensitive film was guarded against distortion; it was he who first devised and constructed micrometric apparatus for measuring the impressions upon the plates; and he who first put this apparatus into practical use in executing his measurements. The large and delicate micrometer screws were made by him or under his constant supervision, at his dwelling-house in this city [New York], and the measurements were effected in his study." It is related by a writer in Nature, in illustration of the pains he took to secure the utmost perfection in the cutting of the threads of his micrometer screw, that he took three years to make a single screw. "In order to test the quality of his work, it struck him that it would be a happy thought to see if it would enable him to rule a grating. He accordingly set the apparatus up in his workroom, and by means of an automatic arrangement kept it going all night, as at that time the local vibrations were fewest. The result was that he was able to make the most perfect gratings [then] known."

For many years Prof. Gould says Mr. Rutherfurd labored at the photographic method of observation without the sympathy or encouraging faith of astronomers generally; "and in 1865 he did me the honor of placing in my hands a large number of measurements, and giving me permission to study and compute them. They had been made in his house, with apparatus designed and in great degree constructed by himself, from photographs which he had personally taken by aid of the telescope which he had himself devised and which was also in his house." At the session of the National Academy of Sciences, held in Northampton, Mass., in August, 1866, Prof. Gould presented a memoir containing the results of computations, made from these data, for deter-

mining the relative positions of thirty-one stars in the Pleiades. On the same day Mr. Rutherfurd communicated orally to the Academy a detailed account of his experiments, difficulties, and successes, and of the methods which he had finally adopted. His photographs of the moon are remarkable for the fineness of their details.

In 1863 Mr. Rutherfurd published in the American Journal of Science a paper dealing with the spectra of the stars, the moon, and the planets, the first published work of the kind after that of Bunsen and Kirchhoff, and the first attempt at classifying the stars according to their spectra. In this paper he said: "The star spectra present such varieties that it is difficult to point out any mode of classification. For the present, I divide them into three groups: first, those having many lines and bands, and mostly resembling the sun, viz.—Capella, β Geminorum, α Orionis, etc. These are all reddish or golden stars. The second group, of which Sirius is the type, present spectra wholly unlike that of the sun, and are white stars. The third group, comprising α Virginis, Rigel, etc., are also white stars, but show no lines; perhaps they contain no mineral substance, or are incandescent without flame." In 1864 he presented to the National Academy of Sciences a photograph of the solar spectrum obtained by means of bisulphide-of-carbon prisms, containing more than three times the number of lines that had been laid down within similar limits on the chart by Bunsen and Kirchhoff. In the course of his spectrum work, to which he now gave increasing attention, he found, as he had done in photographing, that the apparatus in use was insufficient for his purposes. He noticed that diffraction gratings of finely ruled lines upon glass and metal were preferable to series of prisms for the decomposition of light in spectral study. The best gratings in existence—still imperfect—were those of Nobert, who kept his process a secret. Mr. Rutherfurd—as usual helping himself in invention—devised a ruling engine capable of turning out much finer gratings than those of Nobert, some of which had about seventeen thousand lines to the square inch, and which have been surpassed only by those since made by Prof. Rowland. With these gratings his great photographs of the solar spectrum—more than eleven feet long—were made.

After he ceased to take an active part in astronomical work, Mr. Rutherfurd gave his instruments and photographs to Columbia College: the telescope in December, 1883—and it is now mounted in the observatory one hundred and ten feet above the ground; the machine for making measures in the same year; and his best negatives in November, 1890. This valuable collection of photographs of the sun, the moon, and the star clusters has been placed in a fire-proof vault. It contains, according to a list pub-

lished in the annals of the New York Academy of Sciences, one hundred and seventy-five plates of the sun, one hundred and seventy-four of the solar spectrum, four hundred and thirty-five of the moon, and six hundred and sixty-four of star clusters. The reduction of the measures of the Pleiades plates, taken with the thirteen-inch instrument and measured with the improved machine, undertaken according to the understanding between Mr. Rutherfurd and the college authorities by Prof. Rees and Mr. Harold Jacoby of the observatory, and completed and published only a few days before Mr. Rutherfurd's death, but too late to be examined by him, seem, says Prof. Rees, to indicate an accuracy of measures comparable with the best recent heliometer work. Yet they were all taken between 1865 and 1874. It is intended to continue the reductions till all the measures made with the improved machine—filling some twenty folio volumes of about two hundred pages each—are finished; then to measure the negatives that remain unmeasured, and proceed to their reduction.

Prof. Gould emphasizes the fact that all these plates were made some years before the discovery of the dry-plate process, by the aid of which celestial photography has made such wonderful progress in recent years; and "we owe to him not merely the first permanent records of the relative positions, at a given moment, of all the celestial objects impressed upon the sensitive plates, but the means and the accomplishment of the actual conversion of these records into actual numerical data."

Mr. Rutherfurd demonstrated, contrary to the prevailing opinion, that the albuminated collodion film could be made stable on glass under all conditions of atmospheric change.

Mr. Rutherfurd was a member of the International Meridian Conference that met in Washington in October, 1885, and took a prominent part in its work, framing and presenting the resolution that embodied the conclusions of the conference. He was invited by the French Academy of Sciences in 1887 to become a member of the International Conference on Astronomical Photography held in Paris in that year, and was given by the President of our National Academy of Sciences the appointment as its representative, but the condition of his health forbade his serving. He was an Associate of the Royal Astronomical Society. He was an original member of the National Academy of Sciences, which was incorporated by act of Congress in 1863. In 1867 he was elected President of the American Photographical Society, in the official board of which he had served for many years as first vice-president. During his administration the society became the Photographical Section of the American Institute. For many years he was not only a trustee of Columbia College, but one of the most active and hard-working members of that body. Mr. Ruth-

erfurd's physical condition was delicate during the later years of his life, and not suitable for sedentary occupation, or that which exposed him to sudden changes of weather; but he continued his astronomical work as long as prudence permitted it, then retired wholly from it. His death was brought on by a cold, contracted while traveling to his winter residence in Florida, to which was added the shock caused by the sudden death of his daughter.

Of his personality, Mr. O. G. Mason says, in the Photographic Times: "No one could be long in his presence without feeling that he was a man of rare ability. His tall, erect figure and scholarly face made him conspicuous wherever he went. His dignified, courtly bearing and genial nature made earnest friends of all his acquaintances. His dislike of ostentation and show was a conspicuous trait of his character. He was never known to wear any one of the many decorations, emblems of rank, or acquirements which had been conferred upon him." His signature was his plain name, without the addition of any of the literary and scientific honors and titles he had a right to use. "His liberality in the diffusion of the knowledge which he had gained was known and appreciated by hundreds who sought his advice"; and "his wise counsel was sought and recognized as being of the highest value."

In his address as President of the English Folklore Society, Mr. G. Laurence Gomme mentioned as one of the most important of the folklorist's duties the tracing of the influence of Christianity on traditional belief and usage. The heroes and heroines of folk-tales were certainly not Christians, and Christianity was not even nominally represented, except in Slavic countries and in Spain. Thus a dual system of belief was manifested in many of the tales and traditions. This dualism was illustrated in the cry of an old Scottish peasant when he came to worship at the sacred well: "O Lord, thou knowest that well would it be for me this day, an' I had stoopit my knees and my heart before thee in spirit and in truth as often as I have stoopit them afore this well. But we maun keep the customs of our fathers." In like manner there is still a superstition in Lancashire of a long journey after death. Of a man who died of apoplexy at a public dinner, one of the company remarked: "Well, poor Joe, God rest his soul. He has at last gone to his long rest, wi' a belly full of good meat, and that is some consolation." This survival of paganism was frequently noticed by the early Christian fathers; and the pagan conceptions, as a whole, lasted much longer than many of us would conceive possible. In a sermon preached in 1659 by Mr. Pemble, of the Church of England, the case of an old man is given who, being questioned by a minister touching his faith and hope, replied that God was a good old man and Christ a towardly youth; that his soul was a great bone in his body, and after he was dead, if he had done well, he should be put in a pleasant green meadow. This conception of the soul as a bone in the body was paralleled by the notion of the New-Zealanders that a peculiarly sacred character attaches to the backbone. Other curious customs illustrating the mixture of faiths were referred to in the address.

EDITOR'S TABLE.

ANCIENT AND MODERN SUPERSTITIONS.

IN the interesting work by M. Maspero, entitled Ancient Egypt and Assyria, a translation of which has lately been published in this country (Appletons), a vivid description is given of the way in which, in the fourteenth century B. C., an Egyptian physician would have proceeded to cope with a serious case of disease. Psarou, an officer of high rank, has fallen sick. His wife Khait—here let us quote the author's words—"summons an exorcist to see her husband. Nibamon is unequaled in Thebes for his skill in curing the most violent headaches. He arrives toward evening, accompanied by two servants; one carries his black book, the other a casket filled with the necessary ingredients for manufacturing every variety of talisman on the spot—clay for modeling, plants, dried or freshly culled, consecrated linen, black or red ink, small figures in wax or baked earth. One glance at the patient tells him the cause of the illness: a dead man visits Psarou every night and is slowly devouring him. After a few moments' reflection he takes a little clay, mixes some blades of grass with it, and kneads the whole into a rather large ball, over which he recites in a low tone one of the most powerful incantations contained in his book." Returning next day to ascertain how the sick man is faring, the exorcist finds that the symptoms are worse than the day before. "These incidents distress Nibamon, but do not surprise him. The evil spirits are always unwilling to leave their prey, and always endeavor to dispute it inch by inch with the magician who opposes them. The ghost driven from the head now attacks the stomach, and he will only yield to a new spell." The second incantation succeeds no better than the first, and in a few days the man is dead.

Such were the superstitions of ancient times. Did the exorcists lose their credit because their spells produced no effect? By no means. Whatever recoveries took place would be set down to their credit, while failure to cure would be ascribed to occult causes into which it was either vain or impious to inquire. Had any one in those days proposed a statistical test of the physical efficacy of incantations in the cure of sickness, by tabulating the cases in which such measures had been resorted to and those in which they had not been resorted to, and striking a percentage of recoveries under one and the other system, there would have been a fourteenth-century B. C. anticipation of the execration which a kindred proposition of Prof. Tyndall's met with a dozen or more years ago. Lucky indeed would the ancient skeptic have been, had he escaped with no more unpleasant consequences than averted gazes and a scolding all round. Yet what other method than the statistical could any one now suggest for proving or disproving the efficacy of the incantation business?

Could the ancient Egyptian exorcist be revived in our times it would not be difficult, in the very heart of civilization to introduce him to quarters where he would feel that his art might still be pursued with much pecuniary and social success. There are hundreds of thousands of our fellow-citizens who are willing to pay hard and honestly earned money for medals and charms of one kind and another which by virtue of some ecclesiastical benediction are supposed to have the most remarkable specific properties. One medal will give success in agricultural operations, another

in domestic matters; others are efficacious in the sick-room. The Egyptian exorcist sought to place his patient under the protection of different divinities, and thus to scare away the malignant ghosts that were preying on him. To-day he would find that, in lieu of the divinities whose names he was accustomed to invoke, there were hosts of others, or at least of semi-divinities, with names strange to him, who were credited with exercising tutelary powers exactly similar to those of Isis and Osiris, of Amen and Horus, and the rest. And he would find that the idea of verification as in any way applicable to such pretended powers was just as odious to-day, alike to the victims of delusion and to the priestly class, as it could have been in his own day and generation.

Yet verification will triumph. Slowly but surely the world will come into the conviction that beliefs which shun verification, and practices which can not be brought to the test of utility, have no claim to respect. The edifice of superstition seems still all too solid; but the structure of ordered knowledge which science is building is growing in extent day by day, and little by little is expropriating the ground on which the temple of intellectual darkness has been reared. The gains of science are definitive gains, the losses of superstition are definitive losses. The human mind will never resign to occult and arbitrary agencies any sphere of phenomena which has once been reduced to law. Still, there is much to be done in helping individual minds to cast off their fetters, and to put on instead the wholesome restraints of reason and moral self-control.

"The sensual and the dark rebel in vain,
Slaves by their own compulsion."

The bonds of superstition will only be irretrievably broken when the truths of science are welcomed and honored, not alone for the mastery they give over the outward world, but for the clearer light they throw upon questions of moral obligation.

THE SCIENTIFIC METHOD IN POLITICS.

THE Popular Science Monthly is not a political journal, at least as the word "political" is commonly understood. In the wider and truer sense of the word it is political just in the same degree as it is industrial, commercial, educational, and a dozen other things as well; that is to say, it is interested in the political, as in the industrial, educational, etc., development of the country, and believes that in the extension and application of scientific modes of thought the key to the best possible political and other development will be found. If any recent change in the aspect of our national politics has caused us satisfaction it is in no sense from a party point of view—for parties we utterly ignore—but because, as it seems to us, the change is one which tends to place our national life upon a more natural and rational basis than that which it has occupied for many years past, and to favor the growth of a healthy individualism throughout the whole social organism. We have not hesitated in the past to speak of the false and hurtful relations which a general policy of what is commonly called "protection," but what, as Mr. Spencer points out, should properly be called "aggression," establishes between the national Government and various more or less powerful private interests; and it is not unnatural, therefore, if we now rejoice at the prospect of at least a very sensible abatement of the evils of that system. But we rejoice still more to think of the ulterior and indirect results of the approaching change in our national policy. True intellectual manhood has not been attained until men have learned to trust Nature, to test all opinions and schemes by the touchstone of natural law, and, as a necessary result, to despise swaddling clothes and

leading strings and all the paraphernalia of creeping childhood or timorous imbecility. We see before us, as we believe, a prospect of manhood for the American people—such a manhood as they have never before attained to—one of the chief signs of which will be a proud confidence in themselves, and, in connection and through harmony therewith, a noble and generous bearing toward all other nations. Heretofore men politically prominent among ourselves have not been ashamed to suggest that the best policy for us was the one that wrought most evil to other countries, and have thus fed and stimulated all that was meanest and most malignant in the minds of those whom they addressed. There has thus been cultivated among a people which ought, from its advantages of position, to be the most cosmopolitan and broadly philanthropic of all nations a tone of feeling more petty and parochial than could perhaps be found in any other community of the modern world. The mark has, however, been overshot, and the better feeling and better sense of the American people are now, we may trust, about to assert themselves. To be too sanguine in regard to the coming change would only lead to disappointment; but that in the main a better spirit will preside over our national life in the future we confidently believe. Once let the American people make fair trial of themselves under a *régime* of liberty, and nothing will lure them back to the lame and sinister devices which have been so delusively put forward in the past as the props and safeguards of national prosperity.

But not in the political sphere alone, as we have already hinted, is progress to be anticipated. The moment is propitious for an advance all along the line. It is science that has won the battle of liberty, and science should reap its reward in a fuller recognition of its claims. When we say that science has won the battle of liberty, what we mean is that the full, ample, and exhaustive discussion of economical questions that has taken place before the American people has brought certain conclusions into a clear light; the truth has forced its way through the mists of sophistry and all the obstructions that selfishness and prejudice could place in its path. The result, the great result, is that many minds have been opened to the recognition that in the recent election it was not a party that triumphed, but a principle, a truth, that vindicated itself. Hence the conclusion will inevitably be drawn that in the region of human action there are principles capable of demonstration; in other words, that science, which points the way to demonstrations and is itself built on demonstrations, is the proper guide of life. The applications of this conclusion are too numerous to point out on the present occasion; but we may hope that many such applications will spontaneously suggest themselves to our readers, and that, in such efforts as we ourselves may make hereafter to bring home the lesson, we may have many zealous helpers. The less we can all think of party and the more we can think of principles at the present crisis the better it will be; for it is upon the thorough comprehension and acceptance of a principle, and not on the triumph of a party, that the future welfare of the American people depends.

GOOD ROADS AND COUNTRY LIFE.

An unmistakable demand for good common roads is being heard in all parts of the United States. This demand is rapidly growing in volume and is taking on the systematic organization which is essential to the success of such a movement. That bad roads in this country cause an enormous loss of money each year to those who use them may be clearly proved, but this fact is veiled from many persons because they have never known anything better.

Just how loss arises from bad roads is being shown very ably in the magazine, Good Roads, now in its second year, which is edited by Mr. Isaac B. Potter, of New York. The farmers are the greatest sufferers. Where wagon wheels sink hub-deep in mud at some seasons, a farmer who has much hauling to do must keep one or two more horses than he would need if he had only hard, even roads to go over, and his loss in the wear and tear of horseflesh, harnesses, and wagons is a heavy tax on his income. It often happens that a farmer finds the roads absolutely impassable with a loaded wagon just at the time when some of his produce would bring the highest price if he could haul it to a railroad, and he is forced to wait and take a lower price later. Livery-stable keepers and all other owners and users of horses and vehicles suffer from bad roads in similar ways.

The welfare and prosperity of a district that has bad roads suffer in many respects. If getting about for business or recreation is unreasonably difficult, its inhabitants tend to crowd into the towns and cities rather than live in the more wholesome conditions of the open country. Manufacturing concerns are often driven to place themselves in the villages and draw their employees to them there, when, but for the one item of teaming over bad roads, they could be carried on to better advantage in the country. Good roads would keep the employees of these concerns and the other persons above mentioned in the farming districts, thus making these districts more thickly settled and increasing the value of their lands.

In order to obtain better roads two things are necessary. The first is to create a general conviction that the improvement of our highways is imperative, and that money wisely expended for this purpose is sure to return. The second requisite is to place all road making and mending under the charge of competent road-builders. Various efforts to secure these ends are being made, and the aid of county and State authorities, and even of the national Government, has been invoked to further the movement. While it is very desirable that the highways of adjoining localities should be under some central supervision, so that they may be made to form a connected whole, it may yet be questioned whether the national Government could be an effective agency in road improvement. Why, for instance, should the dwellers beyond the Mississippi and on the Pacific coast be taxed to maintain in Washington a school for road engineers and a museum of road construction that few, if any, of these distant communities could derive any benefit from? A more practicable scheme would be to have instruction in road engineering given at each of the State Colleges of Agriculture and Mechanic Arts. In a country showing such wide differences in soil, rainfall, temperature, and topography between different sections as the United States does, road-building can be taught and administered far more efficiently by the State or the county than by the nation.

There is need of much intelligent care in framing legislation in the interest of the movement for better roads. Annoying prohibitions should be no part of the policy of the road reformers. For instance, large loads carried on wheels having narrow felloes and tires do great damage to roads; hence it has been proposed to prohibit narrow tires on heavy wagons. A much better policy is that adopted in Michigan, of giving a reduction of one half their road-taxes to those who will use broad tires. The movement for good roads shows a lusty vigor. The success that it has already achieved is splendid testimony to the efficiency of voluntary association of individuals, and if its leaders continue to carry it on without the paralyzing patronage of the General Government it is likely to attain great results.

LITERARY NOTICES.

MORAL INSTRUCTION OF CHILDREN. By FELIX ADLER. New York: D. Appleton & Co. International Education Series. Pp. 270. Price, $1.50.

THIS book is a sign of the times. It is one among many responses to the deepening public conviction that character, no less than intellect, demands education if it is to come to its best; education as well reasoned, systematic, and thorough as science and sympathy can make it. In giving this conviction effect, a formidable difficulty is encountered at the very outset. A portion of the American people, neither few in number nor lacking weight in legislation, maintains that the teaching of right conduct can proceed only upon religious sanctions. Hence come the reiterated demands for a division of school-taxes to enable separate schools to be administered by specific churches. On the threshold of his subject Prof. Adler considers these demands, and reviews in particular the example of Germany in uniting church and state education, pressed as it so often is for acceptance in the United States. He points out that in Germany the churches founded the schools; that their control has now passed to the state marks the advance to supremacy of political sentiment. In this country the state it was which founded the schools; were it to admit the churches into partnership in their control, the change would mean a reversal of the current of progress as progress is understood in Germany. Prof. Adler argues that the American nation has a paramount interest in keeping its schools unrestrictedly public, in ignoring the party walls of sects, for in no other way can the diverse elements of its population be fused into unity. And the state in disregarding the sects does not array itself against religion. As to rules of right conduct, all good men are agreed; let these rules be taught in the public schools, leaving their sanctions to be enforced in the churches and Sunday schools, whose work can accompany without antagonism that of secular instruction. In the public school the teacher has a vastly better opportunity to observe character and direct its development than is possible in the brief and casual work of the religious instructor on Sundays. Moreover, education in duty should be dominant in school work, not incidental. An ethical atmosphere should pervade and mold every lesson. Knowledge and skill are valuable; character is priceless; and knowledge and skill take on a new edge when wisely subordinated to ideals of duty.

Taking a rapid survey of the ordinary course of school instruction, Prof. Adler suggestively brings out the moral side of each study. A child is asked to describe a bird placed before it, and the teacher is not satisfied until the description is strictly accurate. In making the eye conscientious science thus begins; it proceeds step by step only as it faithfully keeps to truth, as it brings thought and word to absolute accordance with fact. History, properly taught, also has high moral utility. It presents examples of heroism, of self-sacrifice, of love of country, of unswerving devotion to principle. The best literature, and especially the best poetry, make an appeal not less stirring to rightward impulses. The great creative books—the masterpieces of Plato, Dante, Shakespeare, Goethe—touch the deepest springs of character; the student rises from their study ennobled by a new sympathy, with a quickened sense of the dignity of human nature. Music, apart from its subtle power to arouse refined emotion, has distinctive value in socializing the will. Love of home and country made the themes of song are echoed in life. Sentiment can be wisely used to re-enforce the reasoned claims of hearth and country, so that at last public opinion brought to a new breadth and soundness shall deservedly have a profounder influence than ever upon the individual life.

Coming to moral instruction proper, Prof. Adler points out that it should always be suited to the age of the child, and he sketches courses for primary and grammar grades. For young children he holds the best vehicle of instruction to be the fairy tale; the excursions of fancy delight a budding mind; the love of adventure, the delight in disguises, can be made to play a telling part in arousing interest in the faithfulness of a Cinderella, or the merciful traits of the younger brother embalmed in the story of the Queen Bee. A good fable always has interest apart from the lesson it conveys; it is essentially truer than history, for it is history's composite photograph; a judicious teacher can select from Æsop, from

the Jataka tales, a great many fables of sterling significance, which, from their point and brevity, can be borne as easily as proverbs in the memory. Advancing to pupils of riper years, our author shows what can be done in adapting the Iliad, the Odyssey, and other great classics to the education of admiration, to the discrimination between motives worthy and unworthy, to the building up of lofty ideals of life. That conduct may be the better practiced as an art, we are next given an outline of morals as a science; the duties which relate to the physical life and the feelings are described and enforced; then, filial and fraternal duties receive attention; third, come the duties to all men of justice and charity; and, lastly, a word regarding the duties of citizenship.

Prof. Adler gives us this book as an outcome of fifteen years' successful work in the class-room, and he intends it to be simply an aid, not a guide, to the teacher. While the founder and leader of the ethical movement, and on fire with the ethical spirit, he is too wise a man not to see the folly of being righteous overmuch. He warns the teacher against that moral microscopy which absorbs itself in trifles, only to find strength lacking when a genuine battle has to be fought. But even strength is not everything. It is, after all, at surfaces mainly that we touch, and so we have emphasis laid on grace, on fine manners, as the true efflorescence of high character, enabling it to win where mere strength would fail. He would not have the aim of the moral teacher too much in evidence, well knowing that it is because the marksman does not point at the bull's-eye that he hits it. While a disciple of Kant and an upholder of a moral law underived from the reckoning of consequences, he is willing to give due credit to the utilitarians. Duty goes further and higher than prudence, yet for a long distance they are companions; righteousness does not work for wages, but why blink the fact that it receives goodly rewards? But, however much character in the making may be aided by prudential considerations, character in its perfection has left them far behind. Duty, at first a matter of conscious purpose, becomes confirmed as the habit of the soul, and flowers at last as impulses from which all sense of effort or calculation of gain has passed away.

On every page this book shows that it comes from a strong, judicious, and richly freighted mind. It demonstrates how the culture of conscience, supplementing and completing the culture of the intellect, can lift education to a plane where it shall address itself not to part of human nature but the whole. Its chapters have been written for the teacher; they contain counsels that every parent in the land would be the better for laying to heart.

THE ELECTRIC RAILWAY IN THEORY AND PRACTICE. By OSCAR T. CROSBY and LOUIS BELL. New York. The W. J. Johnston Company (limited), 1892. Pp. 400. Price, $2.50.

AMONG the industrial applications of electricity none have attained greater commercial importance in recent years than electric traction. Although experimental work in this field had been carried on both here and abroad for many years, it was not until the great electric revival of a dozen years ago that the subject began to have importance. Even then this form of traction did not take a commercial place comparable with the other applications of electricity. Much detail work had to be done before it could enter upon the industrial stage, and its economy and adaptability to actual service had to be demonstrated by the test of time. Up to about six years ago electric railways may be said to have progressed no further than the experimental stage, but since that time the application of electric traction to street-car service has gone on at an unexampled rate in this country, until now a large number of the cities and towns have one or more electric railways. As is usual in the practical development of a new art, many fruitless experiments had to be made and much money and time wasted. It was early recognized that the method of operation which promised the largest measure of success was that in which the current was conveyed to the moving car by means of a circuit carried along the line, and connection with which was made by some sort of elastic contact carried by the car. But it was not demonstrated until after many trials in just what manner this could be done to provide a reliable and economical service. Attempts were made to use the rails as the

conductors, and also to carry the conductor in a conduit laid between the rails, connection being made between this conductor and the moving car by a contact arm carried by the car. The numerous difficulties apparently inherent in all forms of surface or underground conductors have led to their total abandonment in this country in favor of the overhead conductor familiarly known as the trolley system. In this system the conductor carrying the current to supply the moving cars is strung on poles eighteen or twenty feet from the ground, and connection is made between it and the moving car by means of a long arm affixed to the roof of the car, and carrying at its upper end a contact, generally in the form of a grooved disk. This arm is held against the conductor by springs and is controllable from the car by a rope connection so that it can be pulled down out of connection with the conductor or readily replaced when jolted out of position by the motion of the car. Although this system has encountered much hostility on account of its supposed danger, it has steadily made its way on account of its capacity to adapt itself to all manner and conditions of service, and handle the varying traffic of a street railway expeditiously, economically, and reliably. Inventors are still busy working upon other methods of applying the current, among which probably the most promising is the storage battery. Despite the fact that this method is now in practical service upon two lines in this country, it can not be said to have passed the experimental stage, but it is very generally recognized that this would constitute a final method of electric traction if it can be worked out so as to have the reliability and economy of the trolley system.

This brief epitome of the work in electric traction is set forth in detail by the authors of the present volume. As they state, their work is the first systematic presentation of the subject, and it is therefore a welcome addition to the current literature of the applications of electricity, the more so that it is an extremely well executed one. One of the editors is the editor of the Electrical World, and has, therefore, been in a position to keep himself informed on the history of the subject and to realize what the practical difficulties have been in the development of the art. The authors begin their exposition with a brief consideration of the general electrical principles involved in the dynamo and electric motor, and then pass to a consideration of prime movers, in which they devote considerable space to the theory of the steam engine as well as to a description of the best types of engine to perform the work required in electric traction. They also consider the theory and best forms of water-wheels available. The forms of motors suitable, and the method of mounting them upon the car so as to apply the motion of the armature to the driving of the wheels, are given an amount of space commensurate with their importance, as it is here that the largest amount of detail labor has been necessary in working out the practical problems of the system. A chapter is given to the line, the track, and the power stations, which deal with the practical considerations to be taken into account in this part of the equipment. In the chapter on the efficiency of electric traction there is a very excellent discussion of the subject, ranging from the efficiency of the engine to that of the complete system. A chapter is given to storage-battery traction, in which the authors describe the best forms of battery which have been devised, and point out clearly the difficulties encountered with this form of apparatus, and the large amount of work that yet remains to be done before the storage battery can take its place in economic competition with the trolley. In a chapter on high-speed service an account is given of the experiments conducted by Mr. Crosby at Laurel, Md., with an electric car driven at a speed of over a hundred miles an hour. The authors believe that it is quite practicable to establish an electric railway service in which speeds of one hundred and fifty miles an hour may be maintained, and give calculations of the power required and designs of the electric apparatus and cars. The authors conclude their volume with a chapter on historical notes in which they detail the early experiments in electric traction in which the broad principles were worked out, at a time when the electric battery was the only source of current. Owing to a lack of any economical source of electricity, these early attempts resulted in nothing practical in the way of the establishment of actual roads, but they served the purpose of laying the subject open to future workers and pre-

vented that pre-empting of the field which would have been given by controlling patents at a time when the art was ripe for development. Various miscellaneous matters, that could not well find a place in the body of the work, are treated in an appendix.

SILK DYEING, PRINTING, AND FINISHING. By GEORGE H. HURST. London and New York: George Bell and Sons, 1892. Pp. 226. Price, $2.

THIS is one of the series of technological handbooks, edited by Sir Trueman Wood, Secretary of the Society of Arts, and, like the rest of the series to which it belongs, is excellently done. It is addressed especially to those concerned with the art of which it treats, but is of interest as well to the general reader who may care to know something about an extensive and important industry. The book is made up of a series of papers contributed by the author to the Dyer and Calico Printer, which have been largely recast, and of additional chapters on silk printing and finishing, and testing dyed silks. The author treats of silk fibers, how they are produced by the silkworm, the method of handling the fiber and reeling it, how it is dyed, and how printing is performed. In an appendix he gives a number of recipes for the preparation of color compositions and in a number of plates at the end of the volume he gives samples of dyed materials both of the fiber and the woven goods.

THE SCIENCE OF NUTRITION. By EDWARD ATKINSON. Pp. 179.

MR. EDWARD ATKINSON, the well-known writer on economic and kindred subjects, has in recent years been devoting his attention to the subject of cooking, and has reached some startling conclusions. He contends that the present method of quick cooking at high temperatures is a fundamental mistake; that cooking should be done slowly at temperatures of from 300° to 400°, and in closed vessels which will retain all the vapors and juices. He has found by extended experimenting that when this is done the amount of heat required is but a fraction of that now used, and has in consequence devised an oven in which a meal for six or eight persons can be cooked over an ordinary kerosene lamp, such as the Rochester. His apparatus, which he terms "the Aladdin oven," is simplicity itself. It consists of a box made of non-conducting material, such as paper or wood, in the upper part of which is placed an oven of thin sheet metal. The oven is smaller than the box, so that there is a space all around it for the circulation of the hot products of combustion from the lamp, which sets in the oven portion of the box. The oven is provided with trays upon which different articles may be placed. Mr. Atkinson claims that bread may be baked, meat roasted, fish and vegetables cooked in a much superior manner than by current methods. Cereals, such as oatmeal, hominy, etc., can be cooked overnight, so that the longer time required is not a feature that presents any difficulties.

The present volume is made up of an address by Mr. Atkinson at Columbia College on The Science of Nutrition, of description of the oven and the work it does, and elaborate data upon the value of foods, and the quantities of the different classes of foods necessary for healthy adults. If Mr. Atkinson's contention is well founded, and it appears to be abundantly so by the data he submits, he has made a very distinct step in advance in the important field of domestic economy, and his labor is one with which every housewife should make it a point of becoming acquainted.

QUESTIONS AND ANSWERS ABOUT ELECTRICITY. A First Book for Students. Edited by E. T. BUBIER. Bubier Publishing Co., Lynn, Mass., 1892. Pp. 100. Price, 50 cents.

OF the making of popular books upon electricity and its applications there appears to be no end. Many of these are of value and of real help to the readers to whom they are addressed, while many more are quite useless. To this latter class belongs the present book. Although four writers have contributed to its make-up, and the entire work has probably undergone the scrutiny of each of its authors, they have failed in producing anything approaching an adequate treatment of the subject. The book is addressed to beginners, presumably those who know nothing of the subject, and consequently should be a clear and concise presentation of the subject, beginning with the simplest phenomena and advancing by steps

to the more complex. Instead of this, subjects are treated in no particular logical order, and the reader could only get a very confused jumble of ideas after going over the book. The authors start out with a brief discussion of the theory of electricity, which, even if clearly stated, which it is not, could be comprehended only after some acquaintance with electrical phenomena. The Holtz and Topler static electric machines are described, so far as their mechanical construction is concerned, before the reader is acquainted with any of the phenomena of static electricity, and no attempt is made to explain the principles of their action.

The meaning of electric terms is in many cases not explained until after they have been used in the description of apparatus, and even then in the most cursory way. On the whole the beginner could read the book with but little profit, and it is too scrappy and incomplete to be of much service to any one at all acquainted with the subject.

PICTURES FROM ROMAN LIFE AND STORY. By the Rev. A. J. CHURCH, M. A., lately Professor of Latin in University College, London. Illustrated. New York: D. Appleton & Co. Pp. 344. Price, $1.50.

IN this series of sketches, Prof. Church, the author of Stories from Homer, Stories from Virgil, has depicted various phases of life at Rome under the emperors. We are introduced to the friends of Mæcenas at his villa; pass a day at the home of Horace; attend the elder Pliny at his studies, and follow Martial about the shops of Rome and to the poet's club. Not very different was this early institution from its modern namesake. It included thirty members, but might have had three hundred, and the only drawback to enjoyment was that the poets had to listen to each other's verses! Overwork was not suspected in those vigorous days, and the indefatigable author limits his hours of study only by his capacity to keep awake. He listens to reading at the bath and a shorthand writer accompanies him in his carriage journeys. By such remarkable industry, during a life of fifty-six years, the elder Pliny accomplished a history in twenty-one volumes, a natural history in thirty-seven, and one hundred and sixty note-books. But there are stirring sights to be witnessed in Rome as well as marvels of literary labor—the great fire, the gladiatorial contests, the burning of the Capitol. These, and pictures of conquest, intrigue, and cruelty, fill the darker spaces of the panorama. However, we learn "there were noble men and women even in the worst days of Rome," and their fidelity to high purpose and true heroism challenge the admiration of all ages.

ELEMENTARY LESSONS IN HEAT. By S. E. TILLMAN. New York: John Wiley and Sons, 1892. Second edition. Pp. 162.

THESE lessons have been prepared by Prof. Tillman to meet the requirements of his class-room at the West Point Military Academy, and are designed for the use of teachers and students generally. They cover the usual subjects of a text-book on heat put in a clear and consise form, and, besides this, Prof. Tillman has given special attention to meteorological phenomena, following Prof. Ferrel in the subject of atmospheric circulation, and the theories of tornadoes and storms.

SUNSHINE. By AMY JOHNSON, LL. A. London and New York: Macmillan & Co. Pp. 502. Price, $1.75.

IT may be judged that the author of this work, a teacher of science at South Kensington, has been extremely successful in holding the interest of her audiences. The material of this volume is mainly a reproduction of lectures to her classes upon the subject of light. These are given in the form of stories, and the experiments to which they naturally lead are performed conjointly by teacher and children, while suggestions are added for other tests to be made at home. Sun images, shadows, and photographs are studied in turn. The laws of reflection and refraction, lenses and their uses, the spectrum and the rainbow are explained and variously illustrated. The beautiful phenomena of fluorescence and phosphorescence and the action of sunlight upon the leaf-green form interesting chapters. Soap-bubbles are treated in four lectures. The films are shown in the shapes of windmill, mushroom, and liquid prism. A bubble is blown within a bubble, one tinted with aniline green being seen plainly within another of ordinary color, and a letter-weight

is constructed with a film to test its elasticity. One lecture is devoted to a journey to Moonland which the children take seated at their desks, and two others give information about the sun, related in the form of a dream.

Many of the experiments are novel, and all can be performed with simple apparatus.

The author states that her aim has been to write so that any child who reads the words can understand their meaning; and although children may thus use the book alone, its purpose will be more nearly fulfilled when parent or teacher, thoroughly familiar with the text, tells it in story-fashion to the hearer. The work is also adapted for lectures before evening classes and reading circles, and to this end 127 of the illustrations have been prepared as lantern slides. The practical hints and appendix furnish directions for apparatus and contain further explanation of the principles involved in the lectures, so that a novice in science may begin to learn by teaching others. According to the preface, the author "looks most particularly to the lanternist as the future exponent of popular science."

THE FOOTPATH WAY. By BRADFORD TORREY. Boston and New York: Houghton, Mifflin & Co. Pp. 242. Price, $1.25.

THOSE who follow Mr. Torrey in his rambles through grove and pasture will surely return with sharpened vision. Even in December there are wild flowers to be found in Massachusetts. Not only the belated aster and dandelion, but mallows, groundsels, shepherd's-purse, and cinquefoil, sixteen kinds in all, blossom at this bleak season. In the same month and locality are noted thirty varieties of birds. Not more than ten of these would probably be seen from a window. They, as well as the flowers, must be traced to their haunts. What patience is needed to know the ways of humming-birds can be gathered from the papers entitled A Widow and Twins and The Male Ruby-throat.

But, whether on mountain-top or in the hollow, there is more to be learned than the habits and genealogy of bird and flower. The author gleans much philosophy by the way. The borer gnawing beneath the fallen spruce teaches him content; the pine tree shows him a brave example; while in the diversity of flowers he reads the advantage of individuality, and in the distinguishing excellence of leaf, bark, and fruit he finds the value of specializations.

CALMIRE. New York: Macmillan & Co., 1892. Pp. 742.

THE aim of this anonymous novel is somewhat complex, including both social morality and the influence of scientific thought upon religion. It is shown in the progress of the story that loose notions result in a ragged character, and the author makes an original effort to patch the hero creditably before the close of the scene. The greatness of to-day and the novelty of ideas no longer new exhale from much of the dialogue. The main part of the book consists of lectures upon the conservation of energy and the principles of evolution, relieved by a generous use of slang.

Those who are eager for the story may not care to swallow this diluted science, while those who are in search of science will scarcely look for it here.

PUBLICATIONS RECEIVED.

Adams, W. H. Davenport. Warriors of the Crescent. D. Appleton & Co. Pp. 317. $1.50.

Allen, Harrison, M. D. Papers on Bats. Smithsonian Institution. Pp. 8.

Andrews, Edmund, M. D., and E. W., M. D. Rectal and Anal Surgery. Chicago: W. S. Keener. Pp. 164. $1.50.

"Babet." Ninety-nine Practical Methods of utilizing Boiled Beef, and the Original Recipe for Stewed Chicken. New York: John Ireland. Pp. 122. 75 cents.

Bailey, M. A. American Mental Arithmetic. American Book Company. 35 cents.

Bancroft, Margaret. Report of Two Cases of Individual Training, Haddonfield (N. J.) School for Mentally Deficient. Pp. 8.

Barnes, Mary Sheldon. Studies in American History. Boston: D. C. Heath & Co. Pp. 115. 60 cents.

Brewer, Dr. F. W. Bulletin of Bureau of Hygiene and Sanitation, Chicago World's Fair. Pp. 14.—The Children's Home, do. Pp. 4.

Brigham, Albert P. Rivers and the Evolution of Geographic Forms. Pp. 21.—The Geology of Oneida County, N. Y. Pp. 17.—A Chapter in Glacial History. Pp. 13.

Brooks, W. K., and Herrick, F. H. The Embryology and Metamorphosis of the Macroura. National Academy of Sciences. Pp. 144, with 57 Plates.

Buchanan, S. H. The World and the Book. Published by the author, Clarksville, Ark. Pp. 451.

Burnz, Eliza Boardman. The Step-by-step Primer in Burnz's Pronouncing Print. New York: Burnz & Co. Pp. 94. 25 cents.

Catlin, W. W., Editor. Echoes of the Sunset Club, Chicago. Joseph W. Errant, Secretary. Pp. 235.

Church, A. J. Stories from the Greek Comedians. New York: Macmillan & Co. Pp. 344. $1.

Crothers, T. D., M. D. The Sanitary Side of the Drink Problem. Chicago: American Medical Association. Pp. 11.

Cushing, Frank Hamilton. Manual Concepts. Washington, D. C. Pp. 28.

Denison, Charles, M. D., Denver, Col. Tuberculin and the Living Cell. Pp. 24.

Earle, Charles A. Memoir upon the Genus Palæopsys, Leidy, and its Allies. Philadelphia: Academy of Natural Sciences. Pp. 156, with Plates.

Endlich, F. M. Manual of Qualitative Blowpipe Analysis and Determinative Mineralogy. New York: Scientific Publishing Company. Pp. 456. $4.

Evans, Elizabeth C. The Story of Kaspar Hauser. From Authentic Records. London: Swan, Sonnenschein & Co. New York: Macmillan & Co. Pp. 188. $1.75.

Fawcett, Edgar. The Adopted Daughter. Chicago and New York: F. T. Neely. Pp. 262. 50 cents.

Fay, J. S. Wood's Holl. The Track of the Norseman. Pp. 7.

Ferree, Barr. Comparative Architecture. New York. Pp. 15.

Foster, Michael, and others, Editors. The Journal of Physiology. Vol. XI, No. 6. Cambridge, England. Pp. 300, with Plates. 18s.

Galton, Francis. Hereditary Genius. New York: Macmillan & Co. Pp. 379. $2.50.

Gaye, Selina. The Great World's Farm. New York: Macmillan & Co. Pp. 365. $1.50.

Hart, A. B. Formation of the Union—1750 to 1829. New York: Longmans, Green & Co. Pp. 278, with Maps. $1.25.

Haviland, Alfred. The Geographical Distribution of Disease in Great Britain. London: Swan, Sonnenschein & Co. New York: Macmillan & Co. Pp. 406. $4.50.

Hayes, C. Willard. Geology of Northeastern Alabama. Pp. 86, with Maps.

Heinzen, Karl. The Rights of Women and the Sexual Relations. Boston: Benjamin R. Tucker. Pp. 173.

Herndon, W. H., and Weik, Jesse W. Abraham Lincoln. New York: D. Appleton & Co. 2 vols. Pp. 331 and 348. $3.

Hiorns, Arthur H. Metal Coloring and Bronzing. New York: Macmillan & Co. Pp. 336. $1.

Hobson, E. W., and Jessop, C. M. An Elementary Treatise on Plane Trigonometry. New York: Macmillan & Co. Pp. 290. $1.25.

Holm, Theodore. Notes on the Flowers of Anthoxanthum Odoratum, L. Smithsonian Institution. Pp. 5, with Plate.

Howerton, G. T. Short Talks on Character-Building. New York: Fowler & Wells Co. Pp. 227.

Jackman, Wilbur S. Nature Study for Common Schools. New York: Henry Holt & Co. Pp. 448.

Le Conte, Prof. Joseph. Plato's Doctrine of the Soul, etc., and the Study of Nature. Berkeley, Cal. Pp. 19.—The Relation of Philosophy to Psychology and to Physiology. Philosophical Society of Washington. Pp. 20.

Le Favre, Carrica. The Royal Road to Beauty, Health, and a Higher Development. New York: Fowler & Wells Co. Pp. 85. 25 cents.

Lubbock, Sir John. The Beauties of Nature. New York: Macmillan & Co. Pp. 429. $1.50.

Lydston, G. Frank, M. D. Varicocele and its Treatment. Chicago: W. T. Keener. Pp. 126. $1.25.

Macaulay, Lord. The Second Essay on the Earl of Chatham. American Book Company. Pp. 109. 20 cents.

Maine. Seventh Annual Report of the State Board of Health. Augusta: A. G. Young, M. D., Secretary. Pp. 399.

Martin, F. H., M. D. Electricity, Diseases of Women, and Obstetrics. Chicago: W. T. Keener. Pp. 252. $2.

Merriman, Mansfield. The Strength and Weathering Qualities of Roofing Slates. Pp. 18.

Mitchell, Clifford. Diseases of the Kidneys. Chicago: W. T. Keener. Pp. 431. $3.

Nadaillac, The Marquis de. Manners and Movements of Prehistoric Peoples. New York: G. P. Putnam's Sons. Pp. 412. $3.

Pattern-making, The Principles of. By a Foreman Pattern-maker. New York: Macmillan & Co. Pp. 180. 90 cents.

Peddie, William. Manual of Physics. New York: G. P. Putnam's Sons. Pp. 501. $2.50.

Pellew, Charles E. Manual of Practical Medical and Physiological Chemistry. New York: D. Appleton & Co. Pp. 314. $2.50.

Purdue University School of Agriculture, Lafayette, Ind. Special Winter Course in Live Stock Husbandry. Prospectus. Pp. 4.

Reemelin, Charles. Life: written by Himself. Cincinnati: Weier & Baker, Printers. Pp. 372.

Reyer, Eduard. Geologische und geographische Experimente (Geological and Geographical Experiments). Leipzig: William Engdemann. Pp. 55.

Roads, A Memorial to Congress on the Subject of a Comprehensive Exhibit of. Pp. 110.

Salmon, David. Longmans' Object Lessons. New York: Longmans, Green & Co. Pp. 239. $1.10.

Shufeldt, R. W., M. D. On the Fossil Avifauna of the Equus Beds of the Oregon Desert. Pp. 36, with Plates.

Simpson, Charles T. Notes on the Unionidæ of Florida, etc. Smithsonian Institution. Pp. 32, with Plates.

Smith, Eugene Allen, State Geologist. Sketch of the Geology of Alabama.

Smith, Fanny Morris. On the Evolution and Construction of the Piano. New York: G. Schirmer. Pp. 160.

Thomas, C. H. An Operation for the Cure of Stricture of the Lachrymal Duct. Chicago. Pp. 16.

Tinsley, G. W., Columbus, Ind. Sun-spots. Pp. 4.

Todd, J. E., Vermilion, South Dakota. Striation of Rocks by River Ice. Pp. 4.—Notes on the Geology of Northwestern Iowa. Pp. 8.

True, F. W. Mammals of the Kilima Njaro Region, East Africa. Smithsonian Institution. Pp. 36, with Plates.

Wilson, Sir Daniel. A Lost Atlantis and other Ethnographic Studies. New York: Macmillan & Co. Pp. 411. $4.

Wood, M. Anna. Physical Measurements of Forty Freshman of Wellesley College. Pp. 7.

Zichen, Dr. Theodor. Introduction to Physiological Psychology. London: Swan, Sonnenschein & Co. New York: Macmillan & Co. Pp. 284. $1.50.

POPULAR MISCELLANY.

Early Electric Railways.—According to Mr. Edward Trevett's book on Electric Railroad Engineering, the first electric railway was constructed by Thomas Davenport, a blacksmith, of Brandon, Vt., who exhibited in Springfield, Mass., in 1835, a small model electric engine, running upon a circular track, the circuit being furnished by primary batteries

carried in the car. The invention was crude and of little practical value, "but the idea was there." Three years later, Robert Davidson, of Aberdeen, Scotland, began experiments in order to supplant the steam railway locomotive by the electric locomotive. He constructed a powerful electric motor which was run successfully on several railways in Scotland, attaining a speed of four miles an hour. In 1849 Moses Farmer exhibited an electric engine which drew a small car containing two persons. In 1851 Dr. C. G. Page, of Salem, Mass., constructed an electric engine of considerable power, which drew a car on the Baltimore and Ohio Railroad, between Washington and Bladensburg, with a highest speed attained of nineteen miles an hour. In the same year Thomas Hall, of Boston, built an electric locomotive in which the current was conducted from a stationary source through the rails and the wheels to the motor. Dr. Joseph R. Finney, of Pittsburg, about this time devised a trolley apparatus. In 1879 Messrs. Siemens and Halske exhibited their electric railway at Berlin. The car carried about twenty passengers at about eight miles an hour. In 1880 Mr. Edison worked an experimental road at Menlo Park, N. J. The first commercial electric railway was constructed at Lichterfeld, Germany, in 1881. It is operated by the third rail system. Since then the development of the electric railway has been rapid.

An Indian Girl's Life.—Prayed over at birth, Dr. Shufeldt says, the pueblo girl of Wolpai (Moquis) must have her delicate baby skin well rubbed with fine wood ashes, or else her bones might become loose as she grows older. Very soon she is strapped in her portable cradle and toted about upon her mother's back, but while in the house must, in the same apparatus, be either stood up against the wall or even hung up, where for an hour or more together, in either situation, her sole amusement consists in peering about the "living-room." As soon as she is able to walk she is permitted to toddle about everywhere, and to ascend and descend the house ladder before the second summer has passed over her head. She has no end of toys and playthings to amuse her. Till about seven years old "her days are spent mostly in romping and playing with the numerous children in the pueblo. Innocent of all clothing, and possessing a wholesome dread of water for any other purpose than to drink, she is at this age as wild as a mountain sheep, and can with almost equal celerity run up and down the steep, rocky crags that so abruptly slope down from the pueblo on all sides save one." After her tenth year she assumes the costume of her elder sisters and her girl companions, and is instructed in the duties that pertain to the kitchen, and in pottery and basket-work; and as she grows stronger, in carding and dyeing wool and weaving blankets, mantles, petticoats, garters, and sashes of cotton or wool. At or a little before fifteen she is considered nubile. "She can bake, sew, dye, card, weave, and spin; her nimble fingers fashion the plastic clays into every shape needed for use or ornament; the tender shoots of the willow or the pliable roots of the grasses respond to her fairy touch and round themselves into beautiful baskets, vivid with coloring and repeating the sacred emblems of the butterfly, deer, or thunder-bird. In the number of stews, ragouts, and broths which she knows how to compound of the flesh of the kid or sheep, and such vegetables as the onion, bean, and the aromatic chile, or in the endless diversity of hominy mush, popcorn, and piki bread, she will hold her own with the most ingenious American housewife."

The Eskimo Woman's Knife.—The *ulu*, or woman's knife of the Eskimo, as described in Mr. Otis T. Masons's paper on the subject, finds its modern representative in the saddler's and shoemaker's knives, the tailor's shears, the butcher's and fishmonger's knives, and the kitchen chopping knife. The last presents a curious survival of form with change of function. There are a great many examples of the *ulu* in the National Museum, and there are thousands of pieces of slate, shell, quartzite, and other stone which correspond exactly with the blades of the Eskimo woman's knife. They have been gathered in countless numbers from the places where relics are found; for every woman and every girl among the American aborigines had one or more of these indispensable implements. While some of the number are of a very primitive character, the *ulu* as it now exists is a complex affair,

consisting of a blade and a handle, or grip, with or without some form of lashing. The blade is either a thin piece of slate ground to an edge, a bit of cherty or flinty rock chipped to an edge, a scrap of steel or iron from wrecks of whaling vessels, or good blades made and sold to Eskimos by traders who visit their country. The handle of this common implement varies greatly in material, form, and finish. In form alone the specimens from each typical area are unique. Many of the blades are tightly fitted into a socket or groove of the handle. The woman's knife is found throughout the Eskimo region, from Labrador to Kadiak, of materials in the handles and the blades dependent most largely on what are furnished by the locality. Some of the specimens in the National Museum are as coarse as savagery could make them; others are very beautiful. The same locality furnishes both and intervening kinds; but some areas furnish only coarse work, while others supply the most beautiful. The problem is a complex one, and white influence has crept in to embarrass the question.

Dirt and Cholera.—"Boil your ice," the pithy counsel given by Dr. Daremberg to the people of Paris, in view of the danger of cholera, is made a text by The Lancet for an exhortation to cleanliness. The saying refers to the ascertained fact that the cholera germ is not destroyed by freezing, and there may therefore be danger in ice, but there are lessons in it of much wider application. We have made great advances in sanitary practice, or cleanliness, which is the same thing, but are still guilty of a great many faults; as The Lancet says, speaking of England, but with apt applicability to our own country: "There are spots in abundance that seem almost to be waiting their opportunity to impress more emphatically the lesson that epidemic cholera and filth go hand in hand. There is the barbarous and revolting middenstead system of our northern counties, polluting air and soil by its emanations and soakage; there are similar systems in the south and elsewhere under which it has become a custom to dig two holes in every man's garden and then to pour all liquid filth into one which is called a cesspool, while the drinking-water is drawn from the other one which goes by the name of a well. There are houses by the thousand in which the drinking-water is drawn from a cistern which also serves a water-closet, and which is also placed in direct communication with the house-drain by means of its overflow pipe; and there are houses in every town by the score, and even by the hundred, in which there is no such proper disconnection of house-drain and waste-pipes from the public sewer as to free them from risk of the ingress of that sewer air from public culverts, which may at any moment be a means of conveying the contagium of imported cholera. . . . There are communities who deliberately elect opponents of sanitary reform because they prefer a risk which seems somewhat remote to a certainty of increased rates; there are public bodies who leave individual inhabitants to perform works of cleanliness and scavenging which they are aware they can not properly carry out; and there are householders who live on year after year in dwellings into which they know sewer air can make its way by one channel or another—indeed, such people can be everywhere found in abundance."

Curious Lightning Phenomena.—A curious story is cited in Chambers's Journal of a specimen of the kind of lightning called the fireball, which came down a tailor's chimney in Paris, showing itself the size of a child's head, and moved slowly about the room, at a small height above the floor, looking, as the tailor described it, "like a good-sized kitten rolled up into a ball and moving without showing its paws." It was bright and shining, yet did not seem to give out any heat. After making several excursions in different directions, it rose vertically to the height of a man's head, steered toward a hole in the chimney above the mantel-piece, and made its way into the flue. Shortly afterward there was a violent explosion, which destroyed the upper part of the chimney and threw the fragments on to the roofs of some adjoining buildings. The phenomenon of lightning prints is one of which little is yet known, but which deserves attention. Prof. Poey mentions twenty-four cases of impressions like photographs made by lightning on the bodies of men and animals. Of these, eight were impressions of trees or parts of

trees; one of a bird, and one of a cow; four of crosses; three of circles or of impressions of coins carried about the person; two of horseshoes; one of a nail; one of a metal comb; one of a number or numeral; one of the words of a sentence; one of the back of an arm-chair. Many other instances of similar impressions are recorded.

Diseases of Advancing Age.—Dr. J. F. Alleyne Adams, in his Shattuck Lecture on the Prevention of Diseases, considers some of the causes of the increase of the diseases of mature or advancing age. The first is the natural tendency of an advancing but still imperfect civilization. We have arrived at nullifying the law of natural selection in youth by the care we take of our weaklings, but have not yet reached that high moral condition and power of self-restraint which are needed to enable us to carry out the contest to the end, and these weaklings consequently succumb early in the downward course. A second cause is found in the rapid growth of cities, the influence of the life in which is to degeneration. A third cause appears in the influence of the war, which took away our most vigorous men. Other causes acting more directly are, the general prevalence of digestive disturbances, due in part to an improper diet and in part to a weakness of digestion caused by lack of exercise and mental strain; a lack of general vigor due to insufficient exercise; the excitement and anxiety which pervade all occupations at the present day; and—most potent and destructive—the intemperate use of alcoholic stimulants.

The People of Mashonaland.—A paper concerning the country in South Africa "which has somehow or another got the name of Mashonaland" was read in the British Association by Mr. Theodore Bent. The inhabitants are an oppressed and impoverished race who, raided upon from both sides by Zulus, take refuge in the mountains. They are obviously a race which has seen better days, retaining traces of a higher civilization in their skill in smelting iron, their ornaments, their musical instruments, and many other kindred points. Though of different tribes, the inhabitants all call themselves by one race name, Makalanga. This is philologically the same as Mocaranga, which a Portuguese writer of the sixteenth century called the people of the country; and in the accounts, given at that time, of the manners and customs of the tribes we recognize certain salient features which connect them with the present race. They describe to us the tribal witch-doctor, the ancestor-worship which is still carried on, their methods of catching game, the filing of their teeth, and numerous other customs indubitably connecting them with the present race. Hence it is very clear to us that the country now called Mashonaland has been inhabited for at least a thousand years by the ancestors of the present barbarous race—a race of men who at one time became powerful and almost civilized, owing to their intercourse doubtless with foreign traders, but who during the later centuries have fallen away into barbarism. Among the traits connecting them with external races and pointing to Semitic influences, are: the assumption of a dynastic or tribal name with the disuse of his old name, by each chief, of whatever degree, on his inheriting his chiefdom. Such names are used just as the name Pharaoh was used in ancient Egypt and continue for centuries. Each of the Makalanga tribes has its totem. In M'Topo's country it is the lion into which the spirits of their ancestors are supposed to go, and this animal is believed to fight for them in battle. To the lion they sacrifice annually, and the chief priest of the tribe is called the lion priest, the Mondoro. Other tribes have the crocodile, the leopard, and so forth. Totems of similar nature are found, as Prof. Glover demonstrates, among the tribes of southern Arabia in remote antiquity. In religion the present inhabitants of Mashonaland are distinctly monotheists. They believe in one god whom they term *Mwali*, a great and mysterious personage unapproachable by mortals; so they have elected as their intercessors *Mozimos*, or spirits of their ancestors, to whom they sacrifice annually, and offer prayers for their well-being. The existence among the Makalangas of a day of rest during the plowing season is very curious. They call it "Mwali's" or "God's day." In Mangwendi's country the chief ordains it and orders that his tribe abstain from work on every sixth day during the periods of industry. This day is invariably employed by the men in drink-

ing beer and lying about idle on the rocks. The wooden pillows are the same as the ancient Egyptian pillows. The favorite game of the country, called *Tsufuba*, is closely akin to a game played in India. The common drink, a millet beer, is called *doora*, as in Abyssinia, and is the same as an ancient Egyptian and Asiatic drink. The so-called Mashona piano, consisting of over twenty iron notes fixed to a scale on a square piece of wood and played on a calabash to bring out the sound, has its parallel to-day in Nubia and Lower Egypt. The Makalangas are decidedly a musical race, and easily pick up tunes to play on this instrument. Every chief has his private musician, who plays at all the public entertainments and dances. As to type of countenance, the Makalanga is far the most refined of any of the Kaffir races Mr. Bent has seen.

The First Transatlantic Steamer.—A publication of curious interest is that of the Log of the Savannah, the first steamship that crossed the ocean, which J. Elfreth Watkins has contributed to the report of the United States National Museum. The Savannah was built for a sailing vessel, but attracted the attention, while upon the stocks, of Captain Moses Rogers, who had been associated with Fulton and Stevens in commanding several of the early steamboats. At his instance it was fitted up with engines by a business firm in Savannah, who wished to give that city the credit of starting the first transatlantic steamship line. Her first voyage was made from New York to Savannah, and on the second day occurs the entry: "Got steam up and it came on to blow fresh; we took the wheels in on deck in thirty minutes." This taking in the wheels during a storm through fear of having them washed away or damaged is not mentioned in connection with any other vessel. The ship reached Savannah in eight days and fifteen hours from Sandy Hook. After a voyage to Charleston and return, the vessel was visited by President Monroe, who was greatly pleased with it, and wished it to go to Washington after its Atlantic voyages, to be examined and possibly purchased for the Government service. The voyage to Liverpool began May 22, 1819. On the 24th, at 5 A. M., the Savannah "got under way of Tybee light, and put to sea with steam and sails. At 6 A. M. left the pilot. At 8 A. M. took off the wheels in twenty minutes." This was to insure the wheels getting safely to Liverpool. The Savannah reached Liverpool, steaming up the Mersey, in twenty-nine days eleven hours from Savannah, having run eighty hours under steam. Marwade's English Commercial Report described her steaming, "without the assistance of a single sheet," as being in a style "which displayed the power and advantage of the application of steam to vessels of the largest size." Vessels which saw her steaming on the passage took her to be on fire. The Savannah visited Stockholm, St. Petersburg, and Copenhagen; and returning home, reached Savannah on November 30th, the fortieth day after leaving Arendale, Norway, not using steam till she got inside of the bar. She visited Washington in December. Her owners became embarrassed in consequence of the great fire in Savannah in 1820, and were obliged to sell her. She was stripped of her machinery, and served as a sailing packet till 1822, when she ran ashore on Long Island and went to pieces.

The Two Schools of Psychology.—At the second session of the International Congress of Experimental Physiology, held in London in August, the president, Prof. H. Sidgwick, spoke of the subsidence of the antagonism that prevailed a few years ago between one-sided extreme views on the neurological side and the psychological side respectively. On the one hand, the crude materialism or positivism which pushed contemptuously aside all results of introspective observation had now mostly given way before the general recognition that psychical processes are objects of experience, altogether distinct from the nervous processes which invariably accompany them; and, though we might regard them as "two faces of the same fact," they must admit that they were "incapable of seeing, or even imagining," how the two were connected; and that, in order to know what could be known of the double fact, they must give systematic and careful attention to both its sides. On the other hand, the attempt of some students of mind to mark off a department of mental phenomena elevated above the condition of being accompanied by nervous change, was now, be

thought, generally abandoned, even by the psychologists who were most strongly opposed to materialism; they found, as Shakespeare's Troilus said, that "we can not fight upon that argument."

Insects Injurious to Fruit.—In his paper read at the late meeting of the American Pomological Society on Recent Advances in dealing with Insects affecting Fruits, Prof. C. V. Riley discusses the methods of combating the plum curculio, codling moth, red scale, fluted scale, and other injurious insects, giving the results of recent experiments on those insects. He questions whether more injury is done to-day to our fruits than was done fifty or one hundred years ago. In fact, it is patent that with the advances made of late years in our methods of warfare against these fruit pests less injury relatively is done, but, as the area of fruit culture increases, so does the aggregate of injury and also the number of species that we have to contend with. He warned pomologists to be on their guard against two foreign insects likely soon to appear in this country—the peach ceratitis, a subtropical insect resembling the apple maggot, which is extremely destructive to the peach crop of Bermuda and likely to be troublesome if it once becomes established in Florida and Georgia; and the Japanese peach fruit-worm, which is allied to our codling moth, and in some seasons damages ninety per cent of the peach crop of Japan. He suggested that provision be made for the inspection, at ports of entry, of fruits and plants received from any part of the world from which we know danger threatens.

Leaves of the Water Lily.—Prof. Miall read a paper in the British Association on the leaves of the giant water lily (*Victoria regia*). He exhibited a photograph of a leaf with a child standing on it to illustrate its flotative power. The leaf differed from that of the English water lilies in that the stalk was affixed almost to the center of it, while the deep slit at the base of the leaf was reduced to a mere notch, and in the presence of a raised rim. This latter feature was probably not useful for preventing waves breaking over the leaf, as had been supposed, but for preventing one leaf from sliding over another. This was proved by the fact that if a leaf was allowed to grow apart from others the rim bent down and the whole leaf lay flat upon the water. Any solid object touching the young growing leaf would cause the rim to be retained all round. It had been shown, furthermore, that when one leaf slid over another, the portion which was covered degenerated and lost its power of repelling water. The notch at the base of the leaf was formerly supposed, by Prof. Miall himself, to be of service in getting rid of water from the surface, but further experiments had convinced him that this was an error. He believed that submergence, the means by which he had previously tested them, was not likely to occur in nature, so he resorted to the use of a garden syringe in order to imitate the effect of rain in filling the leaves. He then found that after fifteen minutes' watering the leaf was no fuller than before and that no water had run out through the notch. On holding the leaf up to the light it was found to be as full of pores as a sieve. The spines with which the leaf was covered were probably a protection against the attacks of the apple snail (*ampullaria*), one of the chief enemies of the plant. When the young leaves were unrolling the spines were so close that no animal could possibly get between them to eat the leaf, and in the full-grown specimens it was only the margins of the rim which were accessible.

The Future of Water Powers.—In his address before the Section of Mechanical Science of the British Association, Mr. H. Cawthorne Unwin said that in 1878 Mr. Easton expressed the opinion that the question of water power was one deserving more consideration than it had lately received, and he pointed to the variation of volume of flow of streams as the principal objection to their larger utilization. Since that time the progress made in systems of transporting and distributing power has given quite a new importance to the question of the utilization of water power. There seems to be a probability that in many localities water power will, before long, be used on a quite unprecedented scale, and under conditions involving so great convenience and economy that it may incite a quite sensible movement of the manufacturers toward districts where water power is

available. When textile manufactures began to pass from the condition of purely domestic industries to that of a factory system, the principal mills were erected near river falls, no other power than water power having been found practically useful. "About 1790," says Mr. Kennedy, "Mr. Watt's steam engine began to be understood, and waterfalls became of less value. Instead of carrying the work-people to the power, it was found preferable to place the power among the people." The whole tendency of the conditions created by the use of steam power has been to concentrate the industrial population in large communities, and to restrict manufacturing operations to large factories. Economy in the production of power, economy in superintendence, the convenience of the subdivision of labor, and the costliness of the machines employed, all favored the growth of large factories. The whole social conditions of manufacturing centers have been profoundly influenced by these two conditions—that coal for raising steam can be easily brought to any place where it is wanted, and that steam power is more cheaply produced on a large scale than on a small scale. It looks rather, just now, as if facilities for distributing power will to some extent reverse this tendency. Water power, where it is available, is so much cheaper and more convenient than steam power that it has never been quite vanquished by steam power.

Electric Units.—The committee of the British Association on electrical standards have proposed the following resolutions, with a view to their adoption internationally: "(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance. (2) That 14·4521 grammes of mercury in the form of a column of mercury 106·3 centimetres long at 0° C. be the specified column. (3) That standards in mercury or solid metal having the same resistance as this column be made and deposited as standards of resistance for industrial purposes. (4) That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of a freshly set up column of mercury." With regard to the units of current and electromotive force, it was agreed that the number ·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampère, and the value 1·434 as the electromotive force in volts of a Clark cell. Prof. von Helmholtz expressed his full concurrence in these decisions.

Power of Hypnotic and Verbal Suggestion.—Some most remarkable instances, taxing credulity, of the power of hypnotic suggestion were related at the recent International Congress of Experimental Psychology in London. A communication from Dr. Liebault told of a case of suicidal monomania cured by suggestion, the effect of which he hoped would be, with a few renewals, durable. In such cases the practitioner insists on making repeated affirmations of cure and multiplying the *séances*. Prof. Delbœuf had removed pain by causing the patient to exercise his will, and had cured a woman possessed with the idea of killing her husband and children—charming away the morbid thought by degrees for two hours, then for a day, and then for a week. Dr. Bramwell, of Goole, presented four of his patients in proof of his claim that he could command pain away by the mere spoken word, without inducing the hypnotic trance. He had recently painlessly extracted seven teeth from the woman of the group by merely ordering her not to feel pain; but failed in the eighth tooth, because she had previously formed the conviction that she would feel pain, so that her self-suggestion overbore his suggestion. The same patient had suffered from myopia, being able to read only the third line in the ordinary table of test letters. On his suggestion she had been able to read all the lines; and he could put her into the myopic state or relieve her from it by the word of command. He had been able to produce the same satisfactory results with all his patients by the mere command in a waking state that he had previously produced in a trance. The mere fact of his giving a written order to a patient to sleep enabled the patient to take that order, read it, and go to sleep whenever he needed to do so. He had repeatedly sent patients to a dentist carrying with them a written order not to feel pain, which they read when they sat down in the dentist's chair. He had now patients who

go to sleep by reading the order to do so; the orders would retain their power when he had not seen the patients for weeks; in fact, he had been repeatedly called upon to give them new pieces of paper when the original talisman had worn out. A captain's wife, in the habit of taking sea voyages and being sick, was now regularly relieved by the author's suggestion.

Useful Bacteria.—It is true, says Dr. H. W. Conn, in a paper on Some Uses of Bacteria, that bacteria are occasionally injurious to us, but it is equally true that they are of direct benefit to us; particularly useful are many of them to the farmer. There are the yeasts, for instance—not bacteria, but microscopic plants closely related to them—the fermenting agents by the aid of which we make bread, wine, and beer. Cider having been fermented by yeast into an alcoholic liquid—hard cider—is further changed in time by the agency of bacteria into vinegar. These bacteria grow on the surface of the hard cider, forming a sort of scum which is the "mother" of vinegar. In the ensilage management of silos, the whole process of procuring proper and sweet ensilage is one of properly managing bacteria growth. During the ripening of cream and the development of the aroma that gives its flavor to butter, bacteria are growing within it "with absolutely inconceivable rapidity" to produce the precious changes. But, "if the butter-maker owes something to bacteria, the cheese-maker owes everything to them. The butter-maker can not get the proper aroma without the agency of bacteria, but the cheese-maker can not get anything. By them unpalatable fresh cheese is converted into ripened, strong, pungent, well-flavored cheese. The quality of the cheese depends on the kind of bacteria that are planted in it, and the selection of these bacteria or the method of introducing them constitutes one of the arts of cheese-making, in which much is yet to be learned; and there is another art in keeping out the noxious bacterium, tyrotoxicon, which poisons the cheese. Bacteria are the powerful agents through which dead animal and vegetable matter is removed by decay. Bacteria also have an important agency in plant life, by promoting the decomposition of compounds from which plants are fed. Of special importance is one particular kind of organism known as "the nitrifying organism," which produces nitric acid. But this is not the end of the agency of bacteria in plant life. They are not only of value in ripening your fertilizers and in keeping up this constant growth of Nature, but we have learned . . . that at the very foundation the growth of plants is absolutely dependent upon these organisms, and similarly in the future the continuance of the vegetable world must be also dependent upon them."

Prehistoric Fish Weirs.—The stone implements, potsherds, and other objects found by Dr. H. T. Cresson in the mud near the mouth of Naaman's Creek, Claymont, Delaware, form the subject of a special paper in the records of the Peabody Museum. The objects were found in close association with the decayed remains of stakes or piles, indicating an aboriginal structure of an unknown character. This structure (or structures) Dr. Cresson conjectures to have been originally fish weirs. Herein he agrees with Prof. H. W. Haynes, who deems it safe to consider them fish weirs rather than the remains of a pile-dwelling people. This confirms the words of the fisherman who first brought the stone implements to notice, when he suggested that "the Indians in old times used to hitch their canoes to them and spear fish, and that was the reason why their darts, axes, etc., were found there." Fish weirs have been mentioned by certain early explorers on this continent, and remains resembling such structures have been referred to by more modern writers.

The Ribs of the Gorilla and of Man.—Describing the articular processes of the gorilla as compared with those of man, Prof. Struthers said, in the British Association, that in the gorilla the chest was planted a vertebra lower than in man. The seventh presented all the characters of the normal sixth, the eighth all the characters of the seventh. In man he had seen the whole chest a vertebra too high. He had met with three cases of a rib more than usual. It was common enough in the human body; instead of the ordinary twelve you had one more at the neck much more commonly than below. In the cases of three out of fourteen gorillas the ex-

tra rib was in the lower part of the chest. The gorilla had one more rib than man, but he had never met with the cervical rib in the gorilla in the upper part of the chest. The tendency in the human chest was to move upward; the tendency in the gorilla's chest was to move downward. President Archibald Geikie said that in man the last rib was a diminishing element, that nothing was more striking than the excessive variations in the length of it. Every organ in the body had a marvelous power of persistency, but it seemed as if the last rib was passing out of existence.

Ancient Peruvian Vegetables.—According to Prof. Wittmack, the ancient Peruvians did not suffer from lack of variety of vegetable foods in their bill of fare. The examination of the ancient cemetery at Aricon has brought to light a large number of plant products which were useful to them for various purposes. Among cereals they had several kinds of Indian corn from which they prepared a kind of beer and a brandy. The quinoa (*Chenopodium quinoa*) was also much valued as a breadstuff, and is still cultivated. They had two kinds of phaseolus beans (*Phaseolus pallar* and *P. vulgaris*), and the beans of the mezquite (*Prosopis glandulosa*), which were eaten as a St. John's bread, or ground were much enjoyed with water. Only a few seeds of lupins have been recovered, but the peanut (*Arachis hypogæa*) has been found abundantly. The bulbous foods included manioc, potatoes, which were cultivated on the mountains, and the sweet potato. Of fruits they had bananas and the lucuma (*Lucuma obovata*) of the present Peruvians; the guava, the sapota, peaches, the passion-flower, the anone, and the anana. The large seeds of the *Inga feuilli*, called pacay, were much liked. For greens they had the tender leaves of the quinoa, cucumbers, and tomatoes. Their narcotics included the coca, which was chewed with pulverized bones or lime, but which in the time of the Incas common men were not permitted to enjoy without permission of the king. Tobacco was used only in snuff or as a medicine, but was not smoked. One of the most important drinks was chica, a kind of corn beer. Spanish pepper was in general use. Of plants useful in the arts, they had white and brown cotton, hemp from the agave, and fourcroya and ananas leaves, for fibers. The pith of the agave furnished tinder. For dyestuffs, they had indigo for blue, *Biza orellania*, the fruit of *Coulteria tinctoria*, the bark of *Rhopala ferruginea*, for black and brown, *Bignonia chica* and *Rubia nitida*. The seeds of the soap tree (*Nectandra* or *Mucuna infleza*) were worn as beads. Weaving implements and canes were made from the soft wood of the *Porliera hygrometrica;* and idols, spoons, and other carved articles from the likewise soft wood of *Pavonia paniculata*, while hard woods were fashioned into lance-shafts, etc.

Ethics in Engineer's Work.—Some Moral Factors in the Engineer's Career, as outlined by Mr. Alfred R. Wolff, of the Stevens Institute of Technology, include in the beginning the subordination of the money consideration to the improvement of opportunities for acquiring further knowledge and the right kind of experience in judgment; an impartial estimate of one's own capabilities and the following as a specialty of that in which he can best excel; self-respect; strenuous effort to gain wide culture and foster broad interests outside of his special profession; and good citizenship, with active interests in movements which tend to humanitarian, social, and political advance. Under the maxim "Be honest," the author describes a kind of bribery which is insinuating but powerful. It is when a special machine or device has been recommended or some contract awarded with sole reference to its merits, and the proprietor then offers a commission or gift. All appears harmless; but an inducement has been offered silently for taking, if not on this occasion, then on the next, a more favorable or a biased view to the donor's interest.

Origin of Color Blindness.—After describing the phenomena of color blindness in his address at the British Association, Prof. William Rutherford said: "It must be admitted that the production of nerve-impulses within the terminals of the retina is almost as obscure as ever. It is still the old question, Does light stimulate the optic terminals by inducing vibration or by setting up chemical change? Whichever view we adopt, it seems to me necessary to suppose that all the processes for the production of nerve-impulses can take place in one and the same

terminal, and can be transmitted to the brain through the same nerve-fiber. From Lippmann's recent researches on The Photography of Color it appears that all parts of the spectrum can now be photographed on films of albumino-bromide of silver to which two aniline substances, azaline and cyanine, have been added. It seems, therefore, reasonable to suppose that a relatively small number of substances could enable all rays of the visible spectrum to affect the retina. It seems to me that the question becomes narrowed down to this, Do the nerve-impulses arise from mere vibration or from chemical change in the molecules of the nerve terminal? The photo-chemical hypothesis has much in its favor. We know how rapidly light can induce chemical change in photographic films, and we know that light induces chemical change in the vision purple in the outer segments of the rod-cells of the retina. The fatigue of the retina produced by bright light is best explained on a chemical theory, but it could also be explained on a mechanical theory; for we must remember that even if the nerve-impulses produced in the visual cells were merely a translation of the energy of light into vibration of nerve-molecules, the nerve-impulse has to pass through layers of ganglionic cells before reaching the fibers of the optic nerve, and in these cells it probably always induces chemical change. I have endeavored to place before you a subject that involves physical and physiological considerations of extreme difficulty. I have not attempted to solve the difficulties, but rather to show their nature."

Work of the Forestry Division.—The year 1891, according to chief Fernow's report, witnessed greater activity and interest in forestry than any previous year. A bulletin, What is Forestry? issued by the division, showed that the forestry interests of this country rank second, if not first, in the value of our annual products reaching the market. The largest share of the expenditure of funds as well as of attention was bestowed upon investigations into the character of our timber trees, or "timber tests." These relate to a judgment of mechanical properties from a simple microscopic or macroscopic examination, and to the determination of the relation in which structure, physical conditions, and mechanical properties stand to the conditions under which the tree is grown. A wide and deep interest is manifested in this work throughout the country. In connection with it a study has been made of the lumber pines of the Southern States, the results of which are given in the present report of the chief of the division. The revision of the botanical and the common names of our arborescent flora is nearly completed and will soon be ready for publication. Distributions have been made of packages of seeds of nine important conifers to State agricultural experiment stations, and twenty species of important conifers and deciduous trees to general applicants, besides seeds of the Australian tan-bark wattle to applicants in the Gulf States, the arid Southwest, and the southern part of the Pacific coast region.

The Forerunners of Matches.—Besides the primitive devices for fire-making, Mr. Walter Hough, in a paper on that subject, describes several that were used in civilized countries before matches became universal. The brimstone match is found in Japan as a broad, thin shaving tipped with sulphur; in Mexico it is a cotton wick dipped in sulphur. These are used to catch the sparks from flints or steels. The "spunk," or splint tipped with sulphur, was in common use in this country prior to 1825, and lingered in out-of-the-way places long after the introduction of matches. In parts of France it is still in use with the *briquet* or tinder box. A variation of the spunk match was curled shavings tipped with sulphur. Attempts to supersede the clumsy *briquets* produced the tinder piston, the tinder wheel, and later the first chemical match. The first employment of phosphorus was by dipping the match into a bottle full of phosphorous mastic mixed with oxide of phosphorus. The next was the "instantaneous light box," "eupyrion," "dip splint," or, in the United States, "match-light box"—a tin box or wooden receptacle, containing a glass bottle filled with asbestus soaked with sulphuric acid, and wood splints tipped with sulphur and then dipped in a paste made of chlorate of potash, powdered sugar, and gum arabic, with water. The "prometheans" were tubes of glass filled with sulphuric acid, surrounded with an inflammable mixture

made chiefly of alum and sugar, which, on being broken, gave an instantaneous light. Another "promethean" was composed of equal parts of chlorate of potash and sugar mixed with a solution of gum, while the sulphuric acid was contained in a glass bead imbedded in the paste and rolled up in gummed paper. Chemical contact and flame were produced by crushing with a pair of pliers. The "Döbereiner," named after the German inventor, was an apparatus of some complexity for bringing hydrogen to impinge upon spongy platinum. It was extensively used in Germany and other countries, and is still found in laboratories and can be purchased from instrument-makers. The invention of friction matches is variously assigned to an Englishman and to a German, and to the years 1829, 1830, and 1832. The first United States patent for a friction match was issued in 1832 for a chlorate match.

Silicified Wood in Arkansas.—The occurrence of silicified wood in the sands and gravels of the Tertiary of the lower Mississippi Valley has long been known, but the mentions and studies of it have for the most part been only incidental. No attempt has hitherto been made, according to Mr. R. Ellsworth Call, to recognize the species and fix their value for classification. The fossil woods occur throughout the area covered by Tertiary sands and gravels in Arkansas. When in large masses, they are apparently rarely far removed from beds of Tertiary lignite; if in small masses or in small fragments, they occur in the gravels of nearly all the region and in the beds of the streams and brooks of the area covered by the Tertiary. Occasionally, whole trunks of trees are found, often partially buried in the sands or deeply imbedded in the gravels which cover the flood plains of the creeks and ravines. The microscopic studies of Prof. F. H. Knowlton have shown that the woods belong to both dicotyledonous and coniferous types, the former constituting the first known dicotyledonous wood found in this country in rocks older than Pleistocene, and the first dicotyledonous forms determined by internal structure. The forms described by Prof. Knowlton are new, and therefore of no use for purposes of classification, but otherwise valuable results have been reached by the studies. The specimens found indicate comparatively few species, but these few must have existed in great numbers. Mr. Call's attention has been directed to tracing the connection between these silicified woods and the lignite beds; and he concludes that they are silicified lignite, the silicification of which occurred either while they were still in the clays, or, most often, after they were removed and buried in the sands and gravels.

NOTES.

Mr. T. C. Stearns records, in the Popular Science News, as a result of his observations of many snakes of every usual size, that he finds them lying in the spring on hill slopes in their torpid state. He never saw them lying straight, but they were all in the form of the letter S. He has also noticed that the first movement they make when aroused is toward the tail, and that indifferently whether he is standing at the head or the tail.

A mask in the National Museum which was found in a grave in southeastern Alaska, is described in a special paper by Lieutenant T. Dix Bolles, U. S. N. It is skillfully carved from cedar wood and painted in the usual grotesque manner with native colors, and is marked by the unique peculiarity of having for its eyes two large bronze Chinese temple coins. The grave in which it was found is more than two hundred years old. Lieutenant Bolles regards it as proof that a Chinese junk was, at some time in the past, driven upon the Alaskan coast.

The British Association for the Advancement of Science has been invited to meet in Toronto in 1895 or 1896. Its first visit to Canada took place in 1884, when it assembled in Montreal. Since that year the scientific interests of the city have made rapid strides, the impulse thereto being in large measure due to the interest evoked by the Association's work. In its new technical departments, established through the bequest of the late Mr. Thomas Workman, and by the princely gifts of Mr. William C. McDonald, McGill University is as thoroughly equipped as any university in America. Mr. Peter Redpath, who gave the beautiful building for its Natural History Museum, has given a handsome building, fast approaching completion, for its library. The muster-roll of McGill is now 650.

At a meeting held in October the trustees of Columbian University, Washington, D. C., elected three chemists to as many chairs in the faculty: Dr. E. A. de Schweinitz, lately of the United States Agricultural Department, Washington, was elected Professor

of Chemistry in the medical department; Prof. Charles E. Munroe, formerly of the Annapolis Naval Academy and lately of the United States Torpedo Station, Newport, R. I., was elected to the chair of Chemistry in the university; Prof. H. Carrington Bolton, of New York city, was elected "Non-resident Lecturer on the History of Chemistry," a position created expressly for him, and the first of this title in the United States.

PROF. G. C. CALDWELL, of Cornell University, regards the healthfulness of oleomargarine as dependent largely on the quality of the material from which it is made; and finds that there is no positive proof that it has ever been made from unwholesome materials, or that any disease has ever been communicated to man by its use. He is of the opinion that when it is properly made from fresh and clean materials it differs but slightly in healthfulness from butter. Yet it is not so good as butter; for when oleomargarine was substituted for butter in a blind asylum at Louisville, Ky., the children, although they had no knowledge of the change, gradually ate less and less of the new butter, and finally declined it altogether—without making any complaint, or exhibiting any evidence of bad effects on their health.

ACCORDING to a description by Prof. Pickering, of the Boyden station observatory near Arequipa, Peru, the air is so clear there that stars of the 6·5 magnitude are picked out by the naked eye with great ease, and when the moon is not too bright the eleven Pleiades can always be counted. The nebula in Andromeda forms also a very conspicuous object, "appearing larger than the moon," while in the thirteen-inch Clark refractor "the whole photographic region of the great Orion nebula, first shown in the Harvard photographs of 1887, is clearly visible to the eye," rendering it "the most splendid object in the stellar universe."

SIR WILLIAM MACGREGOR, British High Commissioner of New Guinea, reports having passed in a recent coasting trip several islands which appeared uninhabited; but on landing he discovered that this appearance was due to their singular configuration. A narrow belt of gently sloping land led from the sea to a steep wall of coral rock, from three hundred to four hundred feet high, from the summit of which an undulating plateau was seen dipping inland. Here the villages were built, from fifty to a hundred feet below the level of the encircling rim, and sheltered from the trade winds. Sir William considers these islands to be upraised atolls, modified in most cases by subsequent wave action on the shore strips.

A MOUNTAINEERING party in the Himalayas, under the direction of Mr. Conway, report having climbed a peak of 20,000 feet and a pass of 18,000 feet in the neighborhood of the mountain K^2; they attempted the ascent of a new peak, which Mr. Conway named the Golden Throne. At 23,000 feet they found that they were on a peak distinct from the Golden Throne, which was still 2,000 feet above them. The peak they ascended was named the Pioneer Peak. It commanded a magnificent view, extending at least 200 miles in one direction. The party suffered from the great altitude, but not severely, and could have climbed a thousand feet higher, if not more.

IN an electric heating apparatus devised by M. M. Olivet, of Geneva, a current is sent from the dynamo into receivers of special metallic composition, which become rapidly heated, but without exceeding a certain temperature, and a heated air current is set up as with steam heating.

AN English paper has an account of a fog in the valley of Wensleydale, near Leyburn, which resembled a great lake with rising hills on either side, that more than half filled the valley; while the hillsides above the level of the apparent flood were reflected with extraordinary distinctness in it. The sun was shining brightly at the time, and the mist began to disperse and the mirage to fade away almost immediately.

ANTS, according to the experiments of Mr. H. Devaux, perceive the difference between sugar and saccharine. They swarmed around sugar that was laid out for them, but deserted saccharine as soon as they tasted it. Even sugar became unpleasant to them when it was mixed with saccharine.

PROF. OTIS T. MASON has been surprised, in examining a large collection of American aboriginal musical instruments, to find that not one was peculiar to women, and that those of the men were never played upon by the women. He is seeking fuller information on the subject.

CANCER has been detected by Prof. Scott, of New Zealand, in specimens of American brook-trout confined in one of the ponds of the Dunedin Acclimatization Society. The author was able to examine several individuals, showing the disease in various stages of advancement; and he gives in his paper a short account of the naked-eye and microscopic appearances of the growth. The occurrence of cancer in animals has been frequently observed of late years.

IN the Shattuck Lecture, on the Prevention of Disease in Massachusetts, accepting the germ theory of the origin of consumption, and in view of the swarms of bacilli in phthisical sputa, Dr. J. F. A. Adams lays down the following rules for precaution against transmitting the disease: (1) Let all sputa be carefully collected and destroyed by fire. (2) Let sputa never be deposited on handkerchiefs, carpets, floors, or any other

place where it may dry and become mingled with the atmosphere. (3) Never drink from the same glass with a consumptive. (4) Never kiss a consumptive upon the mouth. These rules are equally applicable to pneumonia and perhaps also to bronchitis. It will, therefore, be best to call them, not rules for consumptives, but for *all persons who cough and expectorate.* This will save the patient from the shock of a positive and perhaps too hasty diagnosis.

DR. J. S. BURDON SANDERSON, Waynflete Professor of Physiology in the University of Oxford, has been nominated for President of the British Association at the Nottingham meeting, 1893.

THE claim of Prof. Cyrus Thomas that he has found the Maya hieroglyphics to be in part phonetic, and has ascertained the interpretation of a sufficient number to form a key to the solution of the problem, having been disputed by the distinguished Americanist, Dr. Seler, Prof. Thomas is preparing a paper corroborating his views for publication by the Bureau of Ethnology. In the mean time he has published a paper, presenting some of his proofs, in Science for October 7th.

THE programme of lectures of the Franklin Institute, Philadelphia, for the season 1892–'93, includes the topics of thirty-two lectures to be delivered on Fridays and Mondays, from November 4th to February 27th, on subjects relating to transportation, mining and engineering, economics, electricity, chemistry and physics, evolution, art, and other subjects of scientific and popular interest.

THE name of *fluorography* is given to a process for transferring pictures to glass by means of inks containing fluorides. These inks, when sulphuric acid is applied to them, disengage hydrofluoric acid, which etches upon the glass. A composition, described in the *Génie civil*, consists of 400 parts by weight of glycerin, 200 of water, 100 of fluor spar, 100 of tallow, 50 of borax, and 50 of lampblack.

OLD newspapers are said to be of value for wrapping up winter clothing in summer, because the printer's ink is as noxious to moths and their larvæ as camphor and coal-tar. Being impervious to air, they also make good wrappers for ice and for liquids which it is desired to keep cool.

THE measure of a snail's pace has at last been found. Camille Flammarion is quoted in Daheim as estimating it at fifteen ten-thousandths of a metre per second.

THE modern case of exorcism, related by Prof. Evans in the December Monthly, is supplemented by a news item in the New York Herald of November 21st. The woman Herz brought an action for slander against Father Aurelian, on account of his saying that she had sent a devil into her boy. The case was tried in the courts of Eichstadt, Bavaria, and the woman was awarded small damages. In his defense Father Aurelian testified that he had exorcised the devil from the boy, and supported this evidence by quotations from the writings of the fathers. The boy himself deposed that he knew nothing of the alleged exorcism.

OBITUARY NOTES.

PROF. C. SCHORLEMMER, a distinguished chemist, Professor of Chemistry in Owens College, Manchester, England, died on June 27, 1892. He became assistant to Prof. Roscoe in Owens College in 1861, and was appointed to a professorship in 1874. He was the author of A Manual on the Chemistry of the Carbon Compounds, and, in conjunction with Prof. Roscoe, of an extensive treatise on chemistry.

LIEUTENANT FREDERICK SCHWATKA, the arctic explorer, died in Portland, Oregon, November 2, 1892, from the effects of an overdose of laudanum which he had taken to relieve a habitual stomach pain. He was born in Galena, Ill., in 1849; studied at the university in Salem, Oregon; worked as a printer; was graduated from West Point in 1871, and became a lieutenant in the cavalry; was admitted to the bar in Nebraska in 1875; and received a medical degree at Bellevue Hospital Medical College, New York, in 1876—all while in the army. In 1878 he organized an Arctic expedition, and, accompanied by William H. Gilder, sailed for King William's Land in order to recover relics of Sir John Franklin which the Eskimos said were buried in that region. This expedition, which was successful in its main object, was marked by the longest sledge journey that had been made at that time, and by the discovery of the branch of Back's River that was named after President Hayes. Lieutenant Schwatka afterward explored the course of the Yukon River in Alaska, and commanded the New York Times Alaska Exploring Expedition in 1886. He was the author of several books and magazine articles relating to his travels, and was a popular lecturer. He was an honorary member of several foreign geographical societies, and wore some of their medals.

THE death was recently announced, in the seventy-ninth year of his age, of Robert Grant, Professor of Astronomy in the University of Edinburgh. He was appointed Professor of Astronomy in the University of Glasgow in 1859. In observing the eclipse of the sun in 1860 he discovered the proof of the existence of a continuous envelope round that body. He was the author of numerous astronomical papers and cyclopædia articles; and of a catalogue of 6,415 stars, which is in considerable use.